From:	Colligan, Mary
To:	Conn, Sarah
Cc:	Kohout, Jenifer; Ted Swem; Angela Matz; Bob Henszey; Patrick Lemons
Subject:	Re: Oil and Gas 101
Date:	Friday, January 12, 2018 6:26:34 PM

Thanks Sarah. We have a meeting set up immediately following the RDT meeting on Tuesday with Refuges and MBM to talk about roles and responsibilities re: 1002. We then have a meeting set up with Greg on Friday to hopefully present him with a recommendation and reach agreement. I do think it would be helpful to have some cross education so we all understand each other's roles in the process (authorities, timing, etc.). One of the initial key decisions is going to have to be who is essentially the project manager overall - so while we have a clear role in the process due to our authorities and mandates how much do we want to supplement that by taking on broader coordination duties? Someone is going to have to manage the process and communication and that person should inventory expertise in the Service, develop a schedule of planned industry activities (including all of the preparatory activities), and develop a schedule of FWS authorizations and processes. I can see great value in having a central website/clearinghouse of documents, schedules, etc.

As I said, I am planning to sit down with Refuges and MB on Tuesday and we will then sit down with Greg and Karen on Friday. So, I would appreciate your input and insights on the best way forward for our program and for the region overall.

Thanks,
Mary

On Fri, Jan 12, 2018 at 3:04 PM, Conn, Sarah <sarah_conn@fws.gov> wrote:

> Hi Mary and Jenifer,
>
> I think most of the field office staff who would be working on oil and gas stuff are already pretty savvy about how things work so defiantly won't be flying anyone down.
>
> That said if there is a Fairbanks session we might have a couple of the less experienced folks attend, and I'm sure the Arctic Refuge staff might be interested as this is all fairly new to them (but obviously I'm not responding on their behalf here).
>
> I also wonder if it might be helpful for us (Ecological Services) to somehow explain to the various other FWS programs and players involved with 1002 stuff what our roles usually is in oil and gas leases. It may be helpful for people to have a clearer understanding of the resources and expertise we have within the Service when roles and responsibilities are assigned. Just a thought and adding onto BLM's presentation may not be the best venue.
>
> Sarah
>
> On Fri, Jan 12, 2018 at 1:56 PM, Kohout, Jenifer <jenifer_kohout@fws.gov> wrote:
>
>> Please let me know if you or you staff plan to participate in the Anchorage session on Fri, Jan 19 from 9-3.
>>
>> Also interested to know if the folks in Fairbanks would like us to request a session as well.
>>
>> Thanks, Jenifer

---------- Forwarded message ----------
From: **Colligan, Mary** <mary_colligan@fws.gov>
Date: Fri, Jan 12, 2018 at 12:57 PM
Subject: Fwd: Oil and Gas 101
To: Sarah Conn <sarah_conn@fws.gov>, Jenifer Kohout <jenifer_kohout@fws.gov>, David Wigglesworth <david_wigglesworth@fws.gov>, Patrick Lemons <patrick_lemons@fws.gov>, Drew Crane <drew_crane@fws.gov>

Please check with your staff and check on interest. I know it says Anchorage only, but figured I would get an idea of interest from Fairbanks as well.

Thanks
---------- Forwarded message ----------
From: **Clark, Karen** <karen_clark@fws.gov>
Date: Fri, Jan 12, 2018 at 11:40 AM
Subject: Oil and Gas 101
To: FW7 Directorate <fw7_directorate@fws.gov>

Hi Everyone!

BLM has offered to provide us with an oil and gas 101 session given our increased involvement these days. They would like to get an idea of how many people are interested.

When? Friday January 19 9 am - 3pm

Where? Federal Building, 4th floor Denali Room

Video available? Not at this time. After this initial training, they are open to figuring out options for our staff who aren't in Anchorage.

This is a great opportunity! Please check in with your staff and give me an idea of how many folks you expect will participate.

Thanks, Karen

Karen P. Clark
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1011 E Tudor Rd, MS 374
Anchorage, AK 99503
karen_clark@fws.gov
907.786.3542 office
907.786.3493 direct
907.786.3306 fax

--
Mary Colligan
Assistant Regional Director
Fisheries and Ecological Services
U.S. Fish and Wildlife Service, Alaska Region
1011 E. Tudor Road, MS-361
Anchorage, AK 99503
907-786-3505
cell: 907-223-5945

--
Jenifer Kohout
Deputy Assistant Regional Director for Ecological Services
Alaska Region
U.S. Fish & Wildlife Service
p. (907) 786-3687
e. Jenifer_Kohout@fws.gov

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Mary Colligan
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From: Google Calendar on behalf of Roy Churchwell
To: tina_moran@fws.gov
Subject: New event: 1002 Meeting @ Thu Feb 1, 2018 12:30pm - 1:30pm (AKST) (roy_churchwell@fws.gov)
Date: Thursday, February 1, 2018 9:37:28 AM

1002 Meeting

more details »

When	Thu Feb 1, 2018 12:30pm – 1:30pm Alaska Time
Where	110 Fairbanks Field Office Room (map)
Video call	b5-CIP [redacted]
Calendar	roy_churchwell@fws.gov
Who	• roy_churchwell@fws.gov - organizer

Invitation from Google Calendar

You are receiving this email at the account tina_moran@fws.gov because you are subscribed for new event updates on calendar roy_churchwell@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

From:	Wendy Loya
To:	John Martin; Janet Jorgenson; Tracy Fischbach; Christopher Latty; Angela Matz; Jennifer Reed; John Trawicki; Drew Crane; Edward Decleva; Stephen Arthur; Paul Leonard; Eric Taylor; Randy Brown; Steve Berendzen; Greta Burkart; Mark Miller; Roger Kaye; Hollis Twitchell
Cc:	Stephanie Brady
Subject:	1002 Resource Assessment Team: BLM Contacts
Date:	Thursday, February 1, 2018 12:50:33 PM
Attachments:	Table - FWS Resource Assessment Discipline Subjects Interagency Teams 3....docx

Hi Resource Assessment Team leads,

We received a list of BLM contacts that you should reach out to for discussion about the types of decisions we need to make with regards to potential effects of oil and gas exploration and development on Refuge resources, to discuss if the types of information we have are sufficient making those decisions, and if not, to define what information and research is needed. I expect that most everyone already works with many of these staff, but perhaps there are new contacts you will find useful.

Looking forward to our discussion at 12:30 today. Yesterday afternoon John Martin sent out the template we are using and two examples, and I hope you have had a chance to look at those so we can understand if there areas where we need further discussion and guidance.

Sincerely,
Wendy

Dr. Wendy M. Loya, Coordinator
Arctic Landscape Conservation Cooperative (LCC)
Anchorage, Alaska
907.786.3532 (office)
907.227.2942 (mobile)

Coastal Plain 1002 Area, Arctic NWR, Resource Assessment Needs Teams							
		interagency, interdisciplinary teams					
Discipline Subjects (overall agency facilitators)	**team lead (POC)***	**USFWS** (John Martin)	**BLM –State Office** (Nicole Hayes)	**BLM –Arctic Field Office** (Nicole Hayes)	**USGS** (John Pearce)	**State**	**Other**
soils, permafrost, wetlands	Janet Jorgenson	Wendy Loya Josh Rose	Eric Geisler Scott Guyer				Torre Jorgenson, ABA
coastal resources (including erosion)	Wendy Loya	Wendy Loya	Scott Guyer		Li Erikson Ann Gibbs Bruce Richmond Guy Gelfenbaum Sarah Cook		Cathy Coon, BOEM Ken Dunton, UT Austin
water resources (quality & quantity)	John Trawicki Greta Burkart	John Trawicki Greta Burkart	Alan Peck	Richard Kemnitz	Jeff Conaway		
Climate & Snow	Paul Leonard	Wendy Loya Paul Leonard Greta Burkart	Scott Guyer		Frank Urban Gary Clow		Matthew Sturm, UAF
air quality	Angela Matz	Angela Matz	Alan Peck				
contaminants	Angela Matz	Angela Matz	Mike McCrum	Melody Debenham			
acoustic environment	Mark Miller	Tracy Fischbach Roger Kaye Alfredo Soto	Alan Peck Mark Miller, NSSI	Mark Miller, NSSI Stacey Fritz			Davyd Betchkal, NPS Dave Payer, NPS
biotic communities & vegetation	Janet Jorgenson	Wendy Loya	Scott Guyer	Debbie Nigro Tim Vosburgh			
fisheries	Randy Brown	Randy Brown	Matt Varner	Matt Whitman	Vanessa von Biela		
raptors, resident & migratory birds	Christopher Latty	Christopher Latty Rick Lanctot Roy Churchwell Ted Swem	Casey Burns	Debbie Nigro Tim Vosburgh	John Pearce		
caribou	Steve Arthur	Steve Arthur	Casey Burns	Debbie Nigro Tim Vosburgh	Heather Johnson Brad Griffith		Dave Payer, NPS Ken Whitten, ADF&G
other terrestrial mammals		Steve Arthur Wendy Loya	Casey Burns	Debbie Nigro Tim Vosburgh			Dave Payer, NPS
polar bear		Christopher Putnum Patrick Lemons	Casey Burns	Debbie Nigro Tim Vosburgh			
bowhead whales, ringed and bearded seals		Christopher Putnum Patrick Lemons	Casey Burns	Debbie Nigro Tim Vosburgh	Todd Atwood		[NOAA POC]
cultural resources & historic background	Ed DeCleva	Ed DeCleva Hollis Twichell	Bob King	Joe Keeny			
socioeconomic	Tracy Fischbach Jennifer Reed	Tracy Fischbach Jennifer Reed		Stacey Fritz			
-visitor use			Tom Bickauskus				
-public use			Tom Bickauskus				
-public health	Sara Longan		Sara Longan	Sara Longan			
subsistence resources & lifestyle	Hollis Twichell	Hollis Twichell	Dan Shapr	Stacey Fritz			
wilderness values	Roger Kaye	Roger Kaye	Tom Bickauskus	Donna Wixon			

--placeholders--								
cumulative effects	*--pending--*	*John Martin*						
clean-up & restoration	*--pending--*			Melody Debenham				
	NOTES *pending confirmation							

jwm23Jan2018amUPDATED

From:	Kenneth (Alan) Peck
To:	Matz, Angela
Cc:	Tim Allen; Catherine Collins; Craig Nicholls; David Maxwell
Subject:	Re: Call regarding Coastal Plain 1002 Area Reporting Template Assignment
Date:	Thursday, February 1, 2018 10:07:16 PM

Sounds good Angela. Tim and Catherine, would you set up a conference line number and send an invitation for 8AM for all to call in on (I can't set up a number by phone this evening). Craig can make it but I understand Dave is out. One goal should also be to identify other team members with air expertise.

Thanks.
Alan

Sent from my iPhone

On Feb 1, 2018, at 9:43 PM, Matz, Angela <angela_matz@fws.gov> wrote:

> I'll be happy to call at 8 am tomorrow (Friday) AK time, which is 10 am mountain time. Sorry to make this complicated, but I do not have a conference line. I can call two numbers. For those of you who can make it, could you either let me know if you have a conference line or alternatively, which numbers I should call. I'm assuming Alan and Tim and hoping that others could meet in their offices, but I also don't know where you all are geographically.
>
> Thanks and will check email in the morning for any updates; if I hear none, I'll simply call Alan as that's when he's available.
>
> Thanks.
>
> Angela
>
> On Thu, Feb 1, 2018 at 12:29 PM, Peck, Kenneth (Alan) <kpeck@blm.gov> wrote:
>
> > Hi Angela,
> >
> > Thanks for your email. Yes, I can be available for a call on Friday. I am available between 8 to 9 am AKST. I suggest adding to the call Tim and Catherine plus our BLM air specialists Craig and Dave (all are copied in this email). Completing the task you shared below will require a team effort rather than any one individual.
> >
> > As an FYI , I am traveling and unavailable next week, Feb. 5 to 9.
> >
> > Alan
> >
> > On Thu, Feb 1, 2018 at 11:02 AM, Matz, Angela <angela_matz@fws.gov> wrote:
> >
> > > Hi Alan,
> > >
> > > Thanks for the phone call yesterday. I got back from vacation and have been slammed with oil spill meetings this week, but am looking forward to working full time on the

Arctic Refuge task next week. Ok. Not really looking forward to it, but will be working full time on it next week.

Do you have time for a phone call tomorrow? Just let me know a time and I will make it. I'll also be talking with Tim Allen, FWS air quality person.

This is the email that summarizes the task. I will definitely be depending on you to help fill out the deceptively simple template for air quality.

Thanks again and hope to talk to you tomorrow.

Angela

---------- Forwarded message ----------
From: **Martin, John** <john_w_martin@fws.gov>
Date: Wed, Jan 31, 2018 at 4:14 PM
Subject: Coastal Plain 1002 Area Final Guidance for Reporting Template
To: Janet Jorgenson <janet_jorgenson@fws.gov>, Tracy Fischbach <tracy_fischbach@fws.gov>, Christopher Latty <christopher_latty@fws.gov>, Angela Matz <angela_matz@fws.gov>, Jennifer Reed <jennifer_reed@fws.gov>, John Trawicki <john_trawicki@fws.gov>, Drew Crane <drew_crane@fws.gov>, Edward Decleva <edward_decleva@fws.gov>, Stephen Arthur <stephen_arthur@fws.gov>, Paul Leonard <paul_leonard@fws.gov>, Eric Taylor <eric_taylor@fws.gov>, Randy Brown <randy_j_brown@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, Greta Burkart <greta_burkart@fws.gov>, Mark Miller <memiller@blm.gov>, Roger Kaye <roger_kaye@fws.gov>, Hollis Twitchell <hollis_twitchell@fws.gov>, Wendy Loya <wendy_loya@fws.gov>
Cc: Stephanie Brady <stephanie_brady@fws.gov>

All

Please find attached the basic reporting template. This has not changed from the initial format.

Additionally, two examples are attached for your consideration and referral in preparing your discipline reports: one biological resource and one physical resource.

These reports due **COB 16 Feb 2018**. Further, they are not comprehensive and therefore, include only that known information and missing data deemed the highest priorities for moving forward. It should be understood that this is only a precursor to more comprehensive discipline specialty evaluations that will be generated in the future.

Our discussion tomorrow will provide an opportunity to team leads to get and give information and answer any questions.

Thanks to your efforts on this matter

> > John
> >
> > --
> > *Angela Matz, Ph.D.*
> > *U.S. Fish and Wildlife Service*
> > *4700 BLM Road Anchorage, AK 99507-2546*
> > *angela_matz@fws.gov*
> > *Phone: 907-271-2778   Cell: 907-750-8527*
> > *Fax: 907-271-2786   Toll Free: 1-800-272-4174*
>
> --
> Alan Peck
> Soil, Water and Air Program Lead
> BLM State Office
> 222 W 7th Ave. #13
> Anchorage, AK 99513
> Desk - (907) 271-4411
> Cell - (907) 202-0796

--
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angela_matz@fws.gov
Phone: 907-271-2778   Cell: 907-750-8527
Fax: 907-271-2786   Toll Free: 1-800-272-4174

From:	Burkart, Greta
To:	John Trawicki
Cc:	John W Martin; Wendy Loya; Tracy Fischbach; Meg Perdue; Cathleen Flanagan; Joshua Rose; Angela Matz; David Payer; Christopher Latty; Jennifer Reed; Joanna Fox; Steve Berendzen; Stephen Arthur; Roy Churchwell; Alfredo Soto; Randy Brown
Subject:	Link to Refworks bibliography for Arctic Refuge
Date:	Friday, February 2, 2018 12:12:30 PM

People may find this helpful:

Arctic Refuge bibliography (created and formerly maintained by Alan Brackney):
http://www.refworks.com/refshare/?site=040621159772400000/RWWS6A185318/ArcticRefuge.

Greta Burkart, PhD
Aquatic Ecologist
US Fish and Wildlife Service
Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
101 12 th Ave Rm 236
Fairbanks, AK 99701
ph: (907) 456-0519
fax: (907) 456-0428
email: greta_burkart@fws.gov
www.facebook.com/arcticnationalwildliferefuge

Brown, Randy <randy_j_brown@fws.gov>

Re: 1002 Area material

1 message

von Biela, Vanessa <vvonbiela@usgs.gov> Fri, Feb 2, 2018 at 1:27 PM
To: "Brown, Randy" <randy_j_brown@fws.gov>
Cc: Matt Whitman <MWhitman@blm.gov>

Here are a few comments on the 'simple' fish section. Looks pretty good.

I included a bit of language about the potential for freshwater removal to disrupt the base of fish food webs in case you want any of this information at this stage.

I'm sure we will have more discussions about the information gaps that exist as it pertains to the process that FWS must consider and I look forward to talking with you more about these interesting systems.

-Vanessa

Vanessa von Biela, Ph.D.
Research Fish Biologist
USGS Alaska Science Center
4210 University Drive
Anchorage, AK 99508
(907)786-7073
About Me

On Fri, Feb 2, 2018 at 12:17 PM, von Biela, Vanessa <vvonbiela@usgs.gov> wrote:

> Hi Randy,
>
> Thanks for this information. I'm working through the document and providing some comments.
>
> One information gap that I have already been thinking about is our lack of understanding about the basis of the food web for these fishes. Ken Dunton's lower trophic work in the 1002 lagoons has suggested that terrestrial carbon is an important component to the benthic system and the limited stable isotope information from fish in the coastal Beaufort sea suggest that the terrestrial carbon does move up the food web at least to some extent. If industry will seek to remove freshwater from this landscape, it seems that there would be potential to disrupt the link between terrestrial carbon sources and fish. I suspect that there could also be interesting connections within the freshwater realm (carbon from glaciers or permafrost degredation?) that could be disrupted too. Essentially any fish food web that uses a source of carbon that isn't local to the spot where the fishes lives would be of interest in this context and it would be useful to identify which fish species are more dependent on these non-local carbon sources.
>
> It happens that Ken Dunton and I were already planning to look at fish food webs in the lagoons using a subset of samples captured during our fyke net work to look at current fish communities. Our goals were more a contrast between the food webs supporting fish in lagoons vs open coastal habitats, but the idea of large-scale freshwater removal adds a new twist. We are currently on the look out for a funding source to support that graduate student and the isotope analyses.
> Mike Carey and others have been looking at freshwater fish food webs near Kotzebue in Noatak and there are indications that aquatic food webs do have some very old carbon sources that might reflect an influence of permafrost degradation.
>
> -Vanessa
>
> Vanessa von Biela, Ph.D.
> Research Fish Biologist
> USGS Alaska Science Center
> 4210 University Drive
> Anchorage, AK 99508
> (907)786-7073
> About Me

On Fri, Feb 2, 2018 at 11:17 AM, Brown, Randy <randy_j_brown@fws.gov> wrote:

Hi Vanessa and Matt,

Thanks to you both for agreeing to help with this effort related to fishes in the area. We had a meeting yesterday where the powers that be clarified what they were wanting for this first go-round. Essentially, they want a brief overview of the data we have, information gaps, and suggestions on studies that might be needed. They gave a couple of template examples (attached) that didn't include any references, which I'm not used to producing. In any case, I thought I would provide you both with the current detailed draft I've been working on, references included, and my adjusted summary without any references. I still have a few more citations to add the the overview section but you'll see what I'm doing with it. Matt, you indicated you could help with impact issues related to seismic activity and development. That is not my field (yet). I believe they will eventually want the more intensive material with references eventually so I'm not looking on it as wasted time. Give a shout if you want to talk.

Thanks,

Randy

--

Randy J. Brown
Fishery Biologist
U.S. Fish and Wildlife Service
101 12th Ave., Room 110
Fairbanks, Alaska 99701

Phone: (907) 456-0295
E-mail: <randy_j_brown@fws.gov>

FishesSectionFeb2018_simple_vrv.docx
23K

Subject Area: Fishes

Lead facilitator: Randy Brown, U.S. Fish and Wildlife Service, <randy_j_brown@fws.gov>, (907 456-0295

Individuals contacted: Vanessa von Biela, USGS, <vvonbiela@usgs.gov>, (907) 786-7073; Mathew Whitman, U.S. Bureau of Land Management, <MWhitman@blm.gov>, (907) 474-2249

What do we need to know about fishes and why:

What information is currently available to address the information needs for fishes:

The eastern North Slope in Alaska is endowed with limited freshwater options for fish. As a result, there are only a few species that occupy the freshwater habitats that are available. Lake density is very low east of the Canning River drainage but increases progressively to the west. Several mountain streams cross the coastal plain between the Canning River and the Canadian border. These streams flow during summer with snowmelt, rainfall, perennial springs, and for some streams, melting glaciers, however, only the perennial springs provide flow during winter reducing habitable environments for fishes to about 5% of what was is available during summer.

The nearshore environment in the southern Beaufort Sea, adjacent to the coastal plain of the eastern North Slope in Alaska, is a mix of open coast and lagoons bounded by barrier islands. In summer, water along the coast becomes brackish and relatively warm because of flow from the Mackenzie River and other rivers along the eastern Arctic coastline. The lagoons are relatively shallow, the amplitude of the tides is very small ($\leq$30 cm), barrier islands restrict flow to some extent, and the environment becomes much less salty and much warmer than sea water outside the barrier islands. The lagoons are very productive foraging environments for marine and anadromous species during summer. In winter, in part because of reduced flow between lagoons and the sea, and in part because of ion exclusion during ice formation, some lagoons become hypersaline environments that get even colder than normal sea water under ice. As winter approaches and the lagoons begin freezing up, anadromous fishes return to freshwater environments and marine fishes retreat to adjacent marine habitats~~offshore environments~~.

Commented [vBVR1]: 'offshore' is pretty broad and I suspect the fish don't go further than they need to.

Freshwater species present in the eastern North Slope of Alaska include lake trout *Salvelinus namaycush*, Arctic char *S. alpinus*, Dolly Varden *S. malma*, Arctic grayling *Thymallus arcticus*, round whitefish *Prosopium cylindraceum*, burbot *Lota lota*, ninespine stickleback *Pungitius pungitius*, and slimy sculpin *Cottus cognatus*. Slimy sculpin are known to occur only in drainages west of the Canning River. Round whitefish and burbot are present in the Canning River and large drainages farther west but not east of the Canning River. Lake trout and Arctic char are found only in certain lakes. Dolly Varden are present in three life history forms: anadromous populations in which most members rear in freshwater rivers for 2–4 years then begin migrating to sea to feed each summer; residual dwarf males of the anadromous populations that choose to stay in freshwater rivers rather than migrate to sea; and dwarf resident populations that exist in isolated lakes or perennial springs. Arctic grayling occur in some lakes and also in rivers with perennial springs that are used for overwintering habitat. Ninespine

stickleback occur as both freshwater residents and as anadromous forms. They are common in lakes within the coastal plain and the lower reaches of many rivers throughout the eastern North Slope.

Anadromous species known to occur in or adjacent to the eastern North Slope of Alaska include Dolly Varden, ninespine stickleback, Arctic cisco *Coregonus autumnalis*, broad whitefish *C. nasus*, humpback whitefish *C. clupeaformis*, least cisco *C. sardinella*, chum salmon *Oncorhynchus keta*, pink salmon *O. gorbuscha*, Chinook salmon *O. tshawytscha*, and rainbow smelt *Osmerus mordax*. Dolly Varden and ninespine stickleback are the only anadromous species in this group that maintain populations within the rivers of the eastern North Slope. Dolly Varden are known to migrate long distances along the coast during their summer feeding forays, east to the Mackenzie River and west to the Colville River or beyond, and some individuals migrate into offshore waters as well. Ninespine stickleback appear to be much more localized in nearshore environments. Arctic cisco have natal origins in the Mackenzie River but disperse as juveniles to coastal habitats including the Colville River delta, where many overwinter in brackish environments. Rearing Arctic cisco make annual feeding migrations along shore during summer and eventually return to the Mackenzie River to spawn. Broad whitefish, humpback whitefish, and least cisco that are encountered in nearshore environments in the eastern Arctic have natal origins in either the Mackenzie River to the east or the Sagavanirktok or Colville rivers to the west. Salmon species that occur in the eastern Arctic are thought to be strays from southern Chukchi or northern Bering Sea populations, although some believe that self-sustaining chum salmon populations may exist in the Mackenzie River drainage somewhere. Rainbow smelt are known to spawn in the Mackenzie and Colville rivers as well as in the Kuk River drainage farther west. Dolly Varden and Arctic cisco are the primary food fishes for people in north east Alaska.

There are about 12 species of marine fishes that are commonly encountered in nearshore brackish environments, only four of which are relatively abundant during the summer season. These are fourhorn sculpin *Myoxocephalus quadricornis*, Arctic flounder *Pleuronectes glacialis*, saffron cod *Eleginus gracilis*, and Arctic cod *Boreogadus saida*. While anadromous species tend to migrate along shore in the southern Beaufort Sea, marine species are thought to follow a very different migratory pattern; moving towards shore and into shallow water during summer and away from shore and into deeper water during winter. It is not uncommon to find these four common marine species in brackish environments during summer, or even in the very lower reaches of the rivers in the area.

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Commented [vBVR2]: Arctic cod are fundamentally different from these other species and it may be best to consider them separately. They are not necessarily a nearshore species and they don't necessarily seek out the brackish water—instead probably driven in to nearshore systems by winds

Commented [vBVR3]: Is it worth pointing out that many of these fish populations (FW, anadrmous, and marine) are transboundry stocks shared with Canada?

Commented [vBVR4]: The Arctic Fishery Management Plan has only identified two Target Species of finfish and they are saffron cod and Arctic cod . Thus there is also an interface with NOAA and Essential Fish Habitat for these two species that might be worth mentioning.

What are the key information gaps:

The primary concern with fishes, as related to hydrocarbon exploration and development as practiced in the western Arctic, are the substantial freshwater requirements for domestic needs of large camps, ice road construction, and eventual industrial development. Numerous studies of available water have highlighted the fact that neither lake nor river sources are sufficient for these purposes in the eastern Arctic. It would be good to know how the industry, if they are interested in pursuing development in the

eastern Arctic, intends to solve the water requirement problem. This information will be critical to understanding whether fish habitats, lake, river, or nearshore, will be affected.

If lake sources will be sought as one component of the industry water budget, then lakes of interest will have to be surveyed for depth or bathymetry and the presence and species of fishes. This information will inform permitting water withdrawal so fishes are not adversely impacted.

Water withdrawal from rivers has rarely been permitted in the western Arctic, although collection of land-fast ice has been allowed in some cases. Aufeis does build up in some areas of the eastern Arctic such as the Canning River delta, Sadlerochit Spring, the lower spring on the Hulahula River, and a number of other smaller sites. Many springs that produce aufeis provide essential overwintering habitat for freshwater and anadromous fishes. In some areas aufeis can be several meters thick by spring and contribute in a significant way to river flow volume throughout the following summer. The impact of aufeis removal on fishes that depend on these eastern Arctic spring systems is unclear at this time.

There has been some discussion about building desalinization plants to produce freshwater for industry needs in the eastern Arctic. One of the byproducts of desalinization is a large volume of very concentrated brine that must be disposed of. If desalinization is a real consideration for industry, it will be critical to develop a disposal method that does not alter the annual patterns of salinity and temperature variation in the lagoon and other nearshore environments that anadromous and marine fishes depend on.

What studies or surveys need to be conducted to fill those information gaps:

An understanding of fish food webs will be necessary to evaluate the potential impacts of water withdrawal on the landscape. Freshwater is known to play a key role in delivery of nutrients and carbon sources to aquatic habitats including the productive lagoon foraging environments used by multiple species of marine and anadromous fishes. Identifying the habitats and species most dependent on the delivery of nutrients and carbon sources can provide opportunities to reduce the influence of any water withdrawal on the food webs that support fishes.

From: Churchwell, Roy
To: Christopher Latty
Subject: 1st? draft
Date: Friday, February 2, 2018 3:51:22 PM
Attachments: REPORTING TEMPLATE Birds.docx

Chris,

Here you go. Also, can you send me what Rick sent you?

Roy

--
Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
101 12th Ave. Room 206
Fairbanks, AK 99701
(907) 456-0508
https://www.fws.gov/refuge/kanuti/

REPORTING TEMPLATE

Discipline/Subject Area: Birds

Lead facilitator Chris Latty - Arctic NWR, chris_latty@fws.gov 907.347.4300

Individuals contacted Roy Churchwell (USFWS), Rick Lanctot (USFWS), others?

What do we need to know and why regarding subjects?

1) Determine the distribution and abundance of birds across the 1002 Area.
    a. We need to understand the key habitats and focal areas of bird use in the 1002 Area.
    b. This will help determine areas of non-bird use where development can occur with minimal impact.
2) Determine the phenology of bird use on the 1002 Area.
    a. When are birds arriving, nesting, staging, and migrating in the 1002 Area.
    b. This will help determine the best season of operation that leads to the least impact to the avian community.
3) Understand baseline factors limiting bird populations within the 1002 Area pre-development.
    a. Predevelopment documentation of factors affecting bird populations will allow for a better understanding of the actual anthropogenic affects compered to natural variation.
    b. For example we should have a better understanding of the current population of red and arctic fox using the 1002 Area and how that population impacts the bird community so that if fox benefit from oil development and the population increases we will have that baseline to reference. Furthermore if bird populations decline for some reason, but the fox population is unchanged we will know what predation pressure to expect.

Commented [CRT1]: I think this could be reworded to be more effective.

What information is currently available to address the information needs for subjects?

- Bird abundance and demographic surveys during the initial 1002 Area EIS in the 1980s.
- Aviation waterfowl surveys (name and timeframe?) – current survey is not intensive enough
- PRISM shorebird survey of the 1002 Area in 2002 and 2004
- Shorebird/waterbird abundance and demographic studies at the Canning River in 1979-80, 2002-2007, 2010-2014, 2016-2017.
- Coastal shorebird surveys during staging and migration 2006 – 2011
- Raptor surveys in Brooks Range and foothills out onto Arctic Coastal Plain (timeframe?)

That being said, these data were collected, but are not currently available due to the fact that many are not in electronic files and available for use and analysis.

What are key information gaps?

We don't have an up-to-date assessment of the distribution, abundance, and timing of use of the avian community using the 1002 Area. We don't know where the birds are and how many are using different habitats within the refuge.

We also need an assessment of the current predator community and its effect on nest success, chick and adult survival when birds are using the 1002 area. We don't know the predevelopment impact of predators on the avian community.

What studies/surveys need to be conducted to fill those information gaps?

- Intensive Aviation waterfowl/waterbird surveys
  - This data stream provides distribution and abundance of waterbirds on the 1002 Area
- New PRISM survey
  - This study would provide distribution and abundance of shorebirds, waterbirds, and passerines (?)
- Point count passerine surveys of 1002 Area
  - This work would provide distribution and abundance of songbirds and shorebirds (?) on the 1002 Area
- A census of Brooks Range and foothill rivers for raptor nests
  - Many raptors nest in the Brooks Range, but may use the Arctic Coastal Plain. This will assess nesting habitat and areas for raptors. Do we need some telemetry work to determine ACP use?
- Predator surveys of 1002 accompanied with avian demographic studies.
  - This will determine the predator population with a focus on red and arctic fox (gulls and jaegers?)
  - Also determines the phenology of the avian community

Commented [CRT2]: Not sure if this is that important as I think we might be able to pick up this information on the PRISM survey.

From: Twitchell, Hollis
To: Decleva, Edward
Subject: Re: Arctic 1002, Cultural Resources and Historic Background
Date: Monday, February 5, 2018 12:49:03 PM
Attachments: 1002 Archeology Resource Assessment Template.docx

---

Ed, late getting into the office this AM, are you available to talk now? Haven't got to far on the Assessment, but here's a start if you haven't already.

On Wed, Jan 31, 2018 at 9:01 AM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:

> Will do, Thanks Ed
>
> On Wed, Jan 31, 2018 at 8:53 AM, Decleva, Edward <edward_decleva@fws.gov> wrote:
>
> > And I'm thinking you should phone me.
> >
> > Edward J. DeCleva
> > Regional Historic Preservation Officer
> > U.S. Fish and Wildlife Service, Alaska Region
> > 1011 E Tudor Rd, MS-235
> > Anchorage, AK 99503
> >
> > edward_decleva@fws.gov
> > 907-786-3399
> >
> > On Wed, Jan 31, 2018 at 8:52 AM, Decleva, Edward <edward_decleva@fws.gov> wrote:
> >
> > > Yes. Thank you. I've locked it in.
> > >
> > > Edward J. DeCleva
> > > Regional Historic Preservation Officer
> > > U.S. Fish and Wildlife Service, Alaska Region
> > > 1011 E Tudor Rd, MS-235
> > > Anchorage, AK 99503
> > >
> > > edward_decleva@fws.gov
> > > 907-786-3399
> > >
> > > On Wed, Jan 31, 2018 at 8:45 AM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:
> > >
> > > > Ed, Monday morning 8:30 am would be perfect, I'll be helping Yukon Flats Refuge with flights later in the morning, does that work for you?
> > > >
> > > > On Wed, Jan 31, 2018 at 8:41 AM, Decleva, Edward <edward_decleva@fws.gov> wrote:
> > > >
> > > > > Hey Hollis,
> > > > >
> > > > > While I'd love to meet up with you guys for lunch, I can't. But I also don't want to spoil your lunch time with a phone call. Besides, this can wait a little bit. How about we set something up for Monday, February 5th, instead? I'm open until 3 PM.
> > > > >
> > > > > Edward J. DeCleva
> > > > > Regional Historic Preservation Officer

U.S. Fish and Wildlife Service, Alaska Region
1011 E Tudor Rd, MS-235
Anchorage, AK 99503

edward_decleva@fws.gov
907-786-3399

On Wed, Jan 31, 2018 at 8:33 AM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:

> Steve B and I are flying to Utqiagvik (Barrow) this morning via Anchorage, then to Deadhorse, and on to Utqiagvik. We will be in layover in Anchorage from ~ 1:00 pm till boarding for Deadhorse at 2:15 pm. I could call you with my cell phone during that time, or if you want face to face meeting at the airport, we could plan to meet and have lunch at the airport if that works for you. Steve and I will be leaving the Fairbanks office for the airport about 10:00 this morning. Let me know what works best for you.
>
> On Wed, Jan 31, 2018 at 7:45 AM, Decleva, Edward <edward_decleva@fws.gov> wrote:
>
>> Hi Hollis,
>>
>> Would you be able to talk today at between 1 and 3?
>>
>> If not, how about tomorrow either before 9 or sometime between 11 and 3?
>>
>> I figure we need about 30 minutes.
>>
>> Thank you, Ed
>>
>> Edward J. DeCleva
>> Regional Historic Preservation Officer
>> U.S. Fish and Wildlife Service, Alaska Region
>> 1011 E Tudor Rd, MS-235
>> Anchorage, AK 99503
>>
>> edward_decleva@fws.gov
>> 907-786-3399
>
> --
> Hollis Twitchell
> Assistant Manager
> Arctic Refuge
> 907 456-0512 w
> 907 378-5732 c

--

Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

2018 Coastal Plain 1002 Interdisciplinary Resource Assessment

REPORTING TEMPLATE

> **Cultural Resources and Historic Background / Archeology**

> **Lead facilitator** (Ed DeCleva, Regional Historic Preservation Officer, 786-3399; Hollis Twitchell, Assistant Manager, 456-0512)

> **Individuals contacted** (or who needs to be contacted if unavailable): [may include individuals, teams, institutions or organizations, e.g., Climate Science Centers]

Margan Allyn Grover and Erin Laughlin, U.S. Army Corps of Engineers; Jake Anders, UAA Department of Anthropology;

> **What do we need to know and why regarding subjects?**

There is a long history of archeological research within Arctic NWR beginning in 1914 by Diamond Jenness's excavations at Barter Island (Libbey 1982:22). However, documented cultural work has been sporadic and concentrated on limited areas, dictated either by convenience of access (much of the work has been along the coast) or by specific management needs such as the coastal plain 1002 study area. There has been no synthesis of cultural resource work that has been conducted in Arctic Refuge as a whole, or in particular for the northern half of Arctic Refuge.

During the summer of 1982, an archeological and historical resources reconnaissance of the 1002 area was completed by Edwin Hall and Associates under a contract to the FWS. An extensive helicopter survey of the entire study area was made with emphasis on areas where archaeological or historic sites were most likely to be located. Sites which contained resources most susceptible to damage during winter seismic activities were identified. The locations of approximately 100 sites including sod houses, cache pits, ice cellars, graves and other sites with standing architecture as well as tent rings, flake scatters and modern tent sites were described. Archeological sites may occur almost anywhere in the 1002 area, but the most likely locations have been along the coastal areas and barrier islands and along rivers and streams that cross the coastal plain from the Brooks Range.

In 2010, Margan Grover of the US Army Corps of Engineers conducted a survey of 70 of these cultural sites along the coastal areas from Flaxman Island to the Canadian border to examine the effects of environmental changes and erosion has had on known cultural resources over the past 30 years. The study concluded that of the 69 previously reported archeological sites, 21 (or 30%) were found to have been impacted to some extent by erosion or thermokarsting, and 20 (or28%) had been completely eroded away. She concludes that many of the remaining cultural sites are in imminent threat of eroding in the next decade.

A second brief archeological survey was conducted in the eastern end of the Sadlerochit Mountains just outside and south of the 1002 area by Jake Anders in 2010. Nine archeological sites were located and reported on, 8 of which have not previously been reported. The discovery of these sites has greatly increased the number of known archeological sites in this particular area of the Refuge, and suggests that the pre-contact indigenous land use of the northern foot hills of the Brooks Range within Arctic Refuge was more intense than has previously been thought.

[i.e., what decisions or determinations are required; what are the conservation threats; address what we know about the resources in the area - distribution, abundance, seasonal movements; how they may be impacted by oil and gas development; what mitigation measures available and their effectiveness, subsistence activities?]

> **What information is currently available to address the information needs for subjects?** [include citations – may want to refer to pending USGS annotated literature review?]

> **What are key information gaps?**

Currently there is no complete synthesis of work that has been conducted in the Arctic Refuge as a whole or for the northern half in particular.

A limited number of archeological surveys have taken place on the Refuge due to logistical difficulties of working in remote locations and lack of infrastructure to support investigations in the northern region.

> **What studies/surveys need to be conducted to fill those information gaps?** Please include duration (start and end), staffing and cost estimates.

There is a need for excavation of selected threaten archeological sites for recovering information before it is lost to erosion.

From:	Martin, John
To:	Angela Matz; Mark Miller; Janet Jorgenson; Randy Brown; Christopher Latty; Stephen Arthur; Edward Decleva; Tracy Fischbach; Hollis Twitchell; Roger Kaye
Cc:	Serena Sweet; Wendy Loya; John Trawicki; Stephanie Brady
Subject:	Fwd: Updated invitation: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop P... @ Fri Feb 16, 2018 10am - 12pm (AKST) (john_w_martin@fws.gov)
Date:	Monday, February 5, 2018 1:51:46 PM
Attachments:	invite.ics

All Team Leads

Please be advised that the BLM has offered an additional opportunity to learn about oil and gas field exploration that is of interest for our resource assessments. If warranted, please have at least one team member attend to pass along relevant information to teams.

Thanks

John

---------- Forwarded message ----------
From: **Serena Sweet** <ssweet@blm.gov>
Date: Mon, Feb 5, 2018 at 11:42 AM
Subject: Updated invitation: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop P... @ Fri Feb 16, 2018 10am - 12pm (AKST) (john_w_martin@fws.gov)
To: john_w_martin@fws.gov, stephanie_brady@fws.gov, mnhayes@blm.gov, wsvejnoh@blm.gov, drew_crane@fws.gov, wendy_loya@fws.gov, john_trawicki@fws.gov, zlyons@blm.gov, Eric Taylor <eric_taylor@fws.gov>, steve_berendzen@fws.gov, ctburns@blm.gov, paul_leonard@fws.gov, mdraper@blm.gov, rbrumbau@blm.gov, dwixon@blm.gov, njones@blm.gov

This event has been changed.

BLM Arctic Seismic Process - Follow-up to 1/19 Workshop Presentation **more details »**

Changed: For those of you attending in person at the Federal Building, the meeting will be held in the Kodiak Room on the 4th floor.

When Fri Feb 16, 2018 10am – 12pm Alaska Time

Where **Changed:** Bridge b5-CIP [redacted], Passcode b5-CIP [redacted] (Webex: b5-CIP [redacted], BLM-AK SO Bridge 1 1 866 566 6183 Passcode 3067503, BLM-AK SO Kodiak A Room, BLM-AK SO Kodiak B Room (map)

Calendar john_w_martin@fws.gov

Who

- ssweet@blm.gov - organizer
- stephanie_brady@fws.gov
- mnhayes@blm.gov
- wsvejnoh@blm.gov
- drew_crane@fws.gov
- john_w_martin@fws.gov
- wendy_loya@fws.gov

- john_trawicki@fws.gov
- zlyons@blm.gov
- Eric Taylor
- steve_berendzen@fws.gov
- ctburns@blm.gov
- paul_leonard@fws.gov
- joanna_fox@fws.gov
- mdraper@blm.gov
- rbrumbau@blm.gov
- dwixon@blm.gov
- njones@blm.gov

Going? **Yes** - **Maybe** - **No** more options »

From: Churchwell, Roy
To: Latty, Christopher
Subject: Re: Here is my latest stab at the Resource Assessment - please edit as you see fit :)
Date: Monday, February 5, 2018 2:54:10 PM
Attachments: REPORTING TEMPLATE Birds_CL_RTC_2-4-18.docx

Hello Chris,

I made some edits, and asked a few questions in comments.

Roy

On Mon, Feb 5, 2018 at 1:21 AM, Latty, Christopher <christopher_latty@fws.gov> wrote:

> --
> Christopher Latty
> US Fish and Wildlife Service
> Arctic NWR
> 101 12th Avenue
> Room 236
> Fairbanks, AK 99701
> cell 907-347-4300

--
Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
101 12th Ave. Room 206
Fairbanks, AK 99701
(907) 456-0450
https://www.fws.gov/refuge/kanuti/

REPORTING TEMPLATE

Discipline/Subject Area: Birds

What do we need to know and why regarding subjects?

1) Determine contemporary distribution and abundance of pre-breeding, breeding, and post-breeding birds in the 1002 Area.
   - This information will allow identification of key areas and~~/or~~ habitats for birds. Because the 1002 Area contains far fewer waterbodies compared to further west, like NPR-A, it is likely bird distribution is spotty with some heavily used, high quality habitats intermixed with broad areas of low bird density. It is likely these high density areas only occur in a small portion of the 1002 Area, leaving large sections of the 1002 Area where development may occur without impacting a substantial number of birds.
2) Determine the phenology of bird use in the 1002 Area.
   - Even high quality habitats that host large numbers of birds probably only do so during certain times of year (e.g., coastal delta use by shorebirds during the fall to increase fat stores for migration). If these times are identified, impacts to birds from exploration and development can be reduced while still utilizing the area outside these core periods.
3) Increase our understanding of baseline factors limiting the population size of birds in the 1002 Area.
   - The most important factors to address are those that have been demonstrated to be affected by exploration, industrial activities, or disturbance at developed sites on the Arctic coastal plain (ACP) or in other tundra environments.
   - Of secondary importance is determining more broad limiting factors affecting 1002 Area bird populations. Avian demographics and breeding success is often highly variable between years due to a diverse set of drivers. This information is not only critical in predicting how birds will respond to a stressor, but also when measuring anthropogenic effects by helping to explain some of the underlying natural variability.

What information is currently available to address the information needs for subjects?

Numerous surveys were conducted in the late 1970s through mid-1980s in the 1002 Area, including ground based tundra breeding bird surveys on the coast~~al~~ and~~or~~ inland ~~plots~~, breeding and post breeding bird surveys on barrier islands and lagoons, aerial breeding swan surveys, breeding raptor surveys in the mountains and along rivers, and post-breeding snow goose surveys. Although ~~this~~ these data provide~~s~~ important historic abundance and habitat use, abundance and distribution of many of the most common and at-risk birds using the 1002 Area have changed, in some cases dramatically, as the Arctic has warmed over the last 40 years. Therefore, the data from these earlier surveys may not represent bird populations today in the 1002 Area.

More recent data to address information needs include:

- Shorebird Program for Regional and International Shorebird Monitoring (PRISM) surveys were conducted during the summer in 2002 and 2004 (partial coverage each year) to determine breeding shorebird abundance and distribution.

- Barrier island breeding bird abundance, demographic, and limiting factor studies were performed in 2003/04 and 2014-17 (2003/04 and 2015 only years in which most of the 1002 Area islands were surveyed). Aerial surveys were also conducted along the barrier islands during the breeding season from 1999-2009.
- Breeding raptor surveys in Brooks Range and foothills out into the 1002 Area in xx (timeframe?).
- Since 1986, annual aerial surveys of waterbirds (waterfowl, loons, larids, skuas) have been conducted across much of the Arctic Coastal Plain of northern Alaska, including parts of the ~~the~~ 1002 Area. However, only about one-fourth of the 1002 Area is surveyed, and what is surveyed falls within the low-density strata, leading to overall coverage of less than one half of one percent.
- Breeding shorebird abundance, demographic, and limiting factor studies at the Canning River in 1979-80, 2002-2007, 2010-2014, 2016-2017. Some waterbird and passerine abundance data also collected. More expansive surveys and studies of limiting factors were conducted in 2016-17.
- Coastal shorebird surveys were conducted during fall staging and migration 2006 – 2011.
- Aerial fall staging snow geese surveys occurred in 1992-93, 1997-2001, 2003-04.
- Lagoon surveys of post-breeding and molting waterbirds were conducted in 1999-2003.

Much of the data from these surveys are not currently generally available and need to be entered into well vetted, electronic, publically available databases. Arctic Refuge is currently working with FWS Science Applications to build a database to house ~~one of~~ the more complicated shorebird demographic dataset~~s~~ collected over several decades ~~for varied projects~~.

What are key information gaps?

We are currently lacking contemporary assessments of the distribution, abundance, and phenology for ~~some important bird~~ avian communities in the 1002 Area, including all species during the breeding season (except birds breeding on the barrier islands) and waterbirds and adult shorebirds during fall staging and migration.

- ~~A~~ The PRISM ground survey conducted in 2002/04 is the only breeding bird survey conducted broadly across the 1002 Area since the 1980s. Although primarily designed to estimate shorebird abundance, data on waterbirds and landbirds were also collected. Although this project was a leap forward in knowledge about breeding bird~~s~~ abundance in the 1002 Area, there are many reasons the results should be used cautiously if additional data is not collected. For example, some of most common waterbirds recorded during the survey have increased up to 300% in the last 15 years. Some at-risk species, like Arctic breeding dunlin, have declined xx% at other North Slope study sites since the survey. Estimated population sizes from the USFWS ACP waterbird surveys conducted annually often vary widely between adjacent years; therefore, a single year's data may misrepresent overall trends in abundance for an area using the aerial survey.
- The only other source for waterbird abundance and distribution in the 1002 area comes from the U.S. Fish and Wildlife Service annual aerial surveys of the Arctic Coastal Plain, but that survey only covers about one-fourth of the 1002 Area at the lowest density

Commented [LCC1]: Dave?

Commented [CRT2]: But only in 2002? According to Rick.

Commented [CRT3]: I don't know that we have documented the percentage of the decline. The last paper I read recorded a decline in survival estimates. Rick?

Commented [CRT4]: Is this the same survey described in the last sentence of the previous bullet?

strata. Thus, this survey has little power to detect and determine trends of breeding waterfowl in the 1002 Area.

- Only a few scattered raptor surveys have been conducted in the Brooks Range or along 1002 Area rivers in the last 20 years; therefore, little is known about breeding raptor use of the 1002 Area.
- Although surveys in the early 2000s found large numbers of sea ducks molting along 1002 Area lagoons, no surveys have been conducted in the last 14 years.
- Coastal ~~fall~~ surveys of migrating shorebirds in the fall have demonstrated that ~~the~~ 1002 Area deltas are vital stopover sights for juvenile shorebirds, but the migration of adult shorebirds along the coast is still poorly understood. Adults of a few species were tagged in summer 2017 with ~~gps~~ GPS loggers to track their movements and core stopover sites, more individuals and species are needed before assessments can begin.

We have ~~only limited~~partial information on the limiting factors found to be impacted by development at other areas of the ACP.

- The most commonly cited consequence of industrial activities to birds on the ACP is changes in the avian predator community makeup and abundance, mostly through range expansion and population growth of subsidized predators. We began a project in 2015 to examine the makeup of the predator community on barrier islands and at the Canning River Delta for tundra nesting birds, but preliminary results suggest large inter-annual variation in predator makeup requiring multiple years of data collected. We also do not have data on the underlying predator species densities or any predator data for tundra nesting birds outside the Canning River Delta.
- We do not have current data on contaminant burdens (including hydrocarbon exposure) for most bird species in the 1002 Area.

What studies/surveys need to be conducted to fill those information gaps?

- Conduct breeding season aerial waterbird surveys throughout the 1002 Area to provide information on ~~the~~ waterbird distribution and abundance and to identify areas critical to waterbirds breeding in the 1002. These surveys should be structured to provide complete coverage, but stratified based on habitat.
- Conduct ground-based surveys throughout the 1002 Area during the breeding season to provide shorebird and landbird distribution and abundance estimates. These surveys should be structured to provide complete coverage, but stratified based on habitat.
- Conduct surveys of Brooks Range and foothill rivers for raptor nests.
  - Many raptors nest in the Brooks Range, but may use the Arctic Coastal Plain. This will assess nesting habitat and use areas for raptors.
- Conduct post-breeding surveys to determine distribution and abundance of long-tailed ducks along the coastal lagoons and snow geese on the tundra. In previous surveys both of these species occurred at high densities in areas ~~or during stages~~ where disturbance may cause a negative impact.
- Conduct tagging studies of key waterbird and shorebird species to determine important sites and phenology during the post-breeding period. Recently, miniature GPS~~gps~~ tags have been ~~have been~~ developed for shorebirds and waterfowl that greatly increase both

Commented [LCC5]: Dave?

Commented [CRT6]: Is there a need for small scale tracking study of raptors? Snowy owls? Looking at ACP use?

the spatial and temporal resolution of habitat use by birds. These tags should be used to increase our knowledge of habitat use in the 1002 Area, especially for poorly understood species, but also to provide high-resolution phenology data for birds in the 1002 Area during migration.

- Continue and expand studies on avian predators, with particular emphasis on subsidized predators such as Arctic fox, ~~and~~ red fox, and ravens. Again, new remote sensing technologies like cameras and tracking devices should be used to increase the resolution of information about ~~predators~~ prey preferences and movement patterns of predators in a changing Arctic ~~and movement patterns~~.
- Continue and expand studies on the limiting factors of the predominate and at-risk bird species ~~of birds~~ in the 1002 Area.

From:	Martin, John
To:	Angela Matz; Mark Miller; Janet Jorgenson; Randy Brown; Christopher Latty; Stephen Arthur; Edward Decleva; Tracy Fischbach; Hollis Twitchell; Roger Kaye
Cc:	Wendy Loya; John Trawicki; Stephanie Brady
Subject:	Fwd: Notes from FWS Resource Assessment Team leads for 1002 area
Date:	Tuesday, February 6, 2018 11:47:03 AM

All (apologies for cross-posting)

As resource team leads, please be advised of the meeting notes from our 16 Feb meeting/phone conf.

Thanks

John

---------- Forwarded message ----------
From: **Trawicki, John** <john_trawicki@fws.gov>
Date: Tue, Feb 6, 2018 at 10:06 AM
Subject: Fwd: Notes from FWS Resource Assessment Team leads for 1002 area
To: Greta Burkart <Greta_Burkart@fws.gov>, John W Martin <John_W_Martin@fws.gov>

John-

Please forward to technical team members.

thank you
---------- Forwarded message ----------
From: **Wendy Loya** <wendy_loya@fws.gov>
Date: Mon, Feb 5, 2018 at 4:56 PM
Subject: Notes from FWS Resource Assessment Team leads for 1002 area
To: Angela Matz <angela_matz@fws.gov>, Drew Crane <drew_crane@fws.gov>, John Trawicki <john_trawicki@fws.gov>, Joanna Fox <joanna_fox@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>
Cc: Paul Leonard <paul_leonard@fws.gov>

Hi Angela, Steve, Joanna, Drew and John,

Below are the talking points I shared last week with the lead authors of the FWS Resource Assessments due February 16th by phone. I had a chance to talk with Angela on the phone Friday; Joanna, Drew and John if you could make sure to share these notes with the staff in your divisions that were unable to make the call that would be great.

- Primary purpose: To identify what information we will need to ensure responsible

resource development, from exploration, to leasing to development in order to look *for support to do that work.*

- We are only describing the resources of the coastal plain to the extent that we need to justify why new information or analyses are needed.

- This will not be the only opportunity to identify research, but it is our first combined effort to communicate with leadership what we see as gaps. The audiences are both us (internal) and potentially administrators without scientific expertise.

- The timeline for moving forward with oil and gas on the Refuge is exploration, leasing and development, so we will work to match up the science with those timelines.

- Clearly, science needed to understand seismic activity impacts is the first thing we will face, so please think about whether that will have impacts on your resource area. That can include low-pressure ground vehicles, camps on snow or ice pads, water withdrawals for camp use; ice harvesting for ice roads/pads; disturbance of winter subsistence users and recreationalists; snow tracks persisting on the landscape where compaction occurs; browning or greening of the tundra in the years afterwards; vegetation, soil and thermokarst damage, etc.

- BLM has been tasked with getting to a lease sale within 2 years. For wildlife species in particular, Steve Arthur outlined some important science needs which generally address the questions of which species use what habitats when and how will industrial activities change that? We will need this information to help define the way the refuge is leased, primarily through which mitigation measures are presented in management alternatives.

- We are a mighty but small team and won't be able to do this alone. We may not have the experience needed to evaluate impacts, so we need to reach out to BLM and others to ask for help. We won't have the funding to do all this research, so we'll need to work with BLM, USGS and other partners to get what needs to be done, done. Please don't let your time or expertise limitations be a lens for your resource assessment. Collaborate, please.

- Reports will be compiled and edited to try to communicate the subjects in similar ways. We'll then work as a group to discuss the results and discuss different ways we should prioritize the studies, look for efficient ways to work together on research and evaluate if there are interdisciplinary studies we overlooked.

-

Staff that are still confused or have questions can contact myself or Paul Leonard (in Fairbanks) and we can gladly help work with them to create a path forward.

Thank you,

Wendy

Dr. Wendy M. Loya, Coordinator

Arctic Landscape Conservation Cooperative (LCC)

Anchorage, Alaska

907.786.3532 (office)

907.227.2942 (mobile)

--

John Trawicki
Water Resources Branch Chief
National Wildlife Refuge System, Alaska
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503
Work: (907) 786-3474
Mobile: (907) 360-1656

"The single biggest problem with communication is the illusion that it has taken place"
George Bernard Shaw

From:	Jorgenson, Janet
To:	Burkart, Greta
Cc:	Christopher Latty; Stephen Arthur; John Trawicki; Alfredo Soto; David Payer; Roy Churchwell
Subject:	Re: ALMS, waterbird, mammal and vegetation surveys in riparian corridors or around lake margins?
Date:	Tuesday, February 6, 2018 6:07:48 PM

Riparian zones would be easy to map using manual interpretation of satellite imagery. We digitized riparian zones (off of aerial photos) on the major north slope rivers in the Refuge for the veg mapping in 1994 and that layer is available in our GIS.
At R:\Geodata\Arctic\SurfaceOverlays\NorthSlope_CoverMap\veg18class, files named anwrw_rip.

Riparian willows grow back really well after being smashed by vehicles, much better than upland vegetation types, so that is not an argument for high priority for protection during seismic exploration. You have other reasons, I know.

On Tue, Feb 6, 2018 at 7:49 AM, Burkart, Greta <greta_burkart@fws.gov> wrote:

> Hi Chris, Janet, and Steve,
>
> According to the National Research Council's 2003 report on cumulative effects of oil and gas activities on the North Slope, riparian corridors may be “the most biologically diverse and most affected” terrain type. In the resource assessments, does anyone does anyone have plans to prioritize bird, mammal or vegetation surveys in riparian corridors? If so, please let John Trawicki or myself know so that we have some idea of what is being covered for riparian zones and how we might be able to coordinate.
>
> The NRC report also notes that water withdrawals could have substantial widespread impacts on wet meadow zones and waterbird communities using lakes and ponds. Even though these studies were recommended in 2003 to my knowledge they have never been done. Janet, Rick, Chris, and Roy - do you think there might be some way to coordinate a baseline inventory for surveys that may address this study need? If so, maybe we could meet to talk about it later this week.
>
> Thanks,
>
> Greta
>
> Greta Burkart, PhD
> Aquatic Ecologist
> US Fish and Wildlife Service
> Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
> 101 12 th Ave Rm 236
> Fairbanks, AK 99701
> ph: (907) 456-0519
> fax: (907) 456-0428
> email: greta_burkart@fws.gov
> www.facebook.com/arcticnationalwildliferefuge

--

Janet C. Jorgenson
Botanist
Arctic National Wildlife Refuge
101 12th Ave, Rm 236
Fairbanks, Alaska 99701

907-456-0216

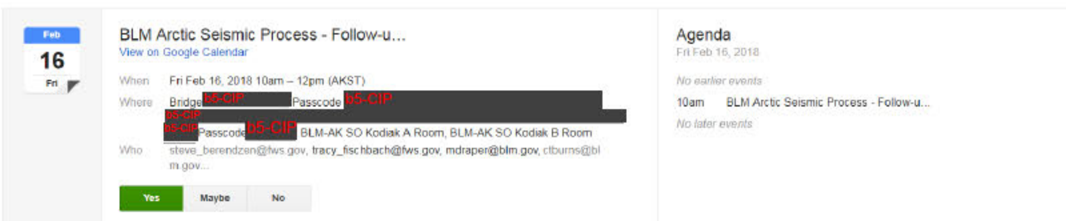
From:	Martin, John
To:	Wendy Loya; John Trawicki; Angela Matz; Mark Miller; Janet Jorgenson; Randy Brown; Christopher Latty; Stephen Arthur; Patrick Lemons; Tracy Fischbach; Hollis Twitchell; Roger Kaye
Cc:	Stephanie Brady; Serena Sweet
Subject:	Invitation: BLM Arctic Seismic Process - Follow-up to 19 Jan Workshop; Fri 16 Feb 2018 1000-1200, Anchorage
Date:	Wednesday, February 7, 2018 9:46:46 AM
Attachments:	image.png Table - Discipline Subjects & Interagency Teams 6Feb2018pmUPDATED.docx

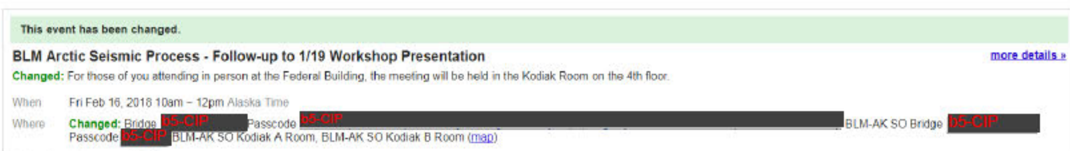
All

This is a resend of the initial invitation as there was some confusion in the earlier invitation. All discipline subject leads are invited, or a representative from each team.

Thanks

John





Feb 16 Fri

BLM Arctic Seismic Process - Follow-u...

[View on Google Calendar]

When	Fri Feb 16, 2018 10am – 12pm (AKST)
Where	Bridge b5-CIP [redacted] b5-CIP [redacted] b5-CIP [redacted] BLM-AK SO Kodiak A Room, BLM-AK SO Kodiak B Room
Who	steve_berendzen@fws.gov, tracy_fischbach@fws.gov, mdraper@blm.gov, ctburns@blm.gov...

Yes | Maybe | No

Agenda

Fri Feb 16, 2018

No earlier events

10am BLM Arctic Seismic Process - Follow-u...

No later events

This event has been changed.

BLM Arctic Seismic Process - Follow-up to 1/19 Workshop Presentation

[more details »]

Changed: For those of you attending in person at the Federal Building, the meeting will be held in the Kodiak Room on the 4th floor.

When	Fri Feb 16, 2018 10am – 12pm Alaska Time
Where	**Changed:** Bridge b5-CIP [redacted] Passcode b5-CIP [redacted] BLM-AK SO Kodiak A Room, BLM-AK SO Kodiak B Room (map)

Coastal Plain 1002 Area, Arctic NWR, Resource Assessment Needs Teams						
	interagency, interdisciplinary teams					
Discipline Subjects (overall agency facilitators)	**team lead (POC)***	**USFWS** (Wendy Loya)	**BLM** (Nicole Hayes)	**USGS** (John Pearce)	**State**	**Other**
soils, permafrost & wetlands	Wendy Loya	Wendy Loya Janet Jorgenson Josh Rose	Eric Geisler Scott Guyer			Torre Jorgenson, ABA
coastal resources (including erosion)	Wendy Loya	Wendy Loya	Scott Guyer	Li Erikson Ann Gibbs Bruce Richmond Guy Gelfenbaum Sarah Cook		Cathy Coon, BOEM Ken Dunton, UT Austin
water resources (quality & quantity)	John Trawicki Greta Burkart	John Trawicki Greta Burkart	Alan Peck	Jeff Conaway		
climate	Wendy Loya	Wendy Loya Paul Leonard Greta Burkart	Scott Guyer	Frank Urban Gary Clow		Matthew Sturm, UAF
air quality	Angela Matz	Angela Matz Scott Covington Catherine Collins	Alan Peck			
contaminants	Angela Matz	Angela Matz	Mike McCrum			
acoustic environment	Mark Miller	Tracy Fischbach Roger Kaye Alfredo Soto	Mark Miller, NSSI Alan Peck			Davyd Betchkal, NPS Dave Payer, NPS
biotic communities & vegetation (invasive species)	Janet Jorgenson	Wendy Loya Janet Jorgenson	Scott Guyer			
fisheries	Randy Brown	Randy Brown	Casey Burns	Vanessa von Biela		
raptors, resident & migratory birds	Christopher Latty	Christopher Latty Rick Lanctot Roy Churchwell Ted Swem	Casey Burns	John Pearce		
caribou	Steve Arthur	Steve Arthur	Casey Burns	Heather Johnson Brad Griffith		Dave Payer, NPS Ken Whitten, ADF&G
other terrestrial mammals		Steve Arthur Wendy Loya	Casey Burns			Dave Payer, NPS
polar bear	Patrick Lemons	Christopher Putnam Patrick Lemons	Casey Burns			
bowhead whales, ringed and bearded seals	Patrick Lemons	Christopher Putnam Patrick Lemons	Casey Burns	Todd Atwood		[NOAA POC]
cultural resources & historic background	Ed DeCleva	Ed DeCleva	Bob King			
paleontological resources	Ed DeCleva	Ed DeCleva	Bob King			
human dimensions (socioeconomics)	Tracy Fischbach Jennifer Reed	Tracy Fischbach Jennifer Reed				
-public use			Tom Bickauskus			
-public health			Sara Longan			
subsistence resources & lifestyle	~~Hollis Twichell~~	~~Hollis Twichell~~	Dan Shapr			
wilderness values	Roger Kaye	Roger Kaye	Tom Bickauskus			
--placeholders--						
cumulative effects	*--pending--*	*John Martin*				

unavoidable adverse effects	*--pending--*	*John Martin*				
oil & gas field abandonment; clean-up & restoration	*--pending--*					
NOTES *pending confirmation						

jwm6Feb2018pmUPDATED

From:	Martin, John
To:	Hollis Twitchell
Cc:	Stephanie Brady; John Trawicki
Subject:	Coastal Plain 1002 Area Team Lead for Subsistence Resources & Rural Lifestyles
Date:	Wednesday, February 7, 2018 9:51:40 AM

Hollis

Discussion with Ed DeCleva indicated that you might be stepping down from team lead. Am interested in confirming so I can make other arrangements for team facilitation, regardless of how this discipline subject will be eventually titled.

Thanks for your efforts

John

From:	Fox, Joanna
To:	Christopher Latty; Stephen Arthur; Janet Jorgenson; Burkart, Greta; Hollis Twitchell; Roger Kaye; Jennifer Reed; Roy Churchwell
Cc:	Steve Berendzen
Subject:	Fwd: Updated invitation: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop P... @ Fri Feb 16, 2018 10am - 12pm (AKST) (joanna_fox@fws.gov)
Date:	Wednesday, February 7, 2018 12:19:28 PM
Attachments:	invite.ics

BLM has scheduled a follow-up workshop/webinar to share additional information with us about seismic work and its impacts. Unfortunately, neither Steve nor I are able to attend. Since we will be addressing impacts and mitigation in the EIS, I'd strongly recommend you participate if available. I have scheduled the Refuges conference room; someone will just need to be responsible for getting the webinar up and running sometime between 9:30 and 10am.

Thanks!
Joanna

____

Joanna L. Fox
Deputy Refuge Manager
Arctic National Wildlife Refuge
101 12th Avenue, Room 236
Fairbanks, AK 99701
(907) 456-0549

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www.facebook.com/arcticnationalwildliferefuge

“Do what you can, with what you have, where you are.” -- Theodore Roosevelt

---------- Forwarded message ----------
From: **Serena Sweet** <ssweet@blm.gov>
Date: Mon, Feb 5, 2018 at 11:42 AM
Subject: Updated invitation: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop P... @ Fri Feb 16, 2018 10am - 12pm (AKST) (joanna_fox@fws.gov)
To: joanna_fox@fws.gov, ctburns@blm.gov, wsvejnoh@blm.gov, john_trawicki@fws.gov, rbrumbau@blm.gov, john_w_martin@fws.gov, zlyons@blm.gov, wendy_loya@fws.gov, paul_leonard@fws.gov, steve_berendzen@fws.gov, stephanie_brady@fws.gov, mdraper@blm.gov, drew_crane@fws.gov, mnhayes@blm.gov, Eric Taylor <eric_taylor@fws.gov>, dwixon@blm.gov, njones@blm.gov

This event has been changed.

BLM Arctic Seismic Process - Follow-up to 1/19 Workshop Presentation [more details »]

Changed: For those of you attending in person at the Federal Building, the meeting will be held in the Kodiak Room on the 4th floor.

When Fri Feb 16, 2018 10am – 12pm Alaska Time

Where **Changed:** Bridge b5-CIP [redacted], Passcode b5-CIP [redacted]

[redacted] BLM-AK SO Bridge [redacted] Passcode [redacted], BLM-AK SO Kodiak A Room, BLM-AK SO Kodiak B Room (map)

Calendar joanna_fox@fws.gov

Who
- ssweet@blm.gov - organizer
- ctburns@blm.gov
- joanna_fox@fws.gov
- wsvejnoh@blm.gov
- john_trawicki@fws.gov
- rbrumbau@blm.gov
- john_w_martin@fws.gov
- zlyons@blm.gov
- wendy_loya@fws.gov
- paul_leonard@fws.gov
- steve_berendzen@fws.gov
- stephanie_brady@fws.gov
- mdraper@blm.gov
- drew_crane@fws.gov
- mnhayes@blm.gov
- Eric Taylor
- dwixon@blm.gov
- njones@blm.gov

Going? **Yes** - **Maybe** - **No** more options »

From: Google Calendar on behalf of Roy Churchwell
To: tina_moran@fws.gov
Subject: New event: BLM Seismic work @ Fri Feb 16, 2018 10am - 12pm (AKST) (roy_churchwell@fws.gov)
Date: Wednesday, February 7, 2018 12:21:55 PM

BLM Seismic work

more details »

When	Fri Feb 16, 2018 10am – 12pm Alaska Time
Video call	b5-CIP [redacted]
Calendar	roy_churchwell@fws.gov
Who	• roy_churchwell@fws.gov - organizer

Invitation from Google Calendar

You are receiving this email at the account tina_moran@fws.gov because you are subscribed for new event updates on calendar roy_churchwell@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

From: Conn, Sarah
To: Louise Smith; Angela Matz; Ted Swem; Brown, Randy
Subject: Fwd: Coastal Plain 1002 Area Environs: FWS-sponsored, Funded or Conducted Studies Gray Literature Search
Date: Thursday, February 8, 2018 10:40:56 AM

Hi Folks,

Another 1002 data call. There is a request for any literature we (the Field Office) may have generated from studies within the 1002 area (I assume this means more recently than the big 1002 studies).

I thought I'd check with you guys as I suspect we may have Hula Hula fish, contaminated site assessments or other things to report?

Please let me know if you can think of anything.

Thanks,

Sarah

---------- Forwarded message ----------
From: **Crane, Drew** <drew_crane@fws.gov>
Date: Thu, Feb 8, 2018 at 9:41 AM
Subject: Fwd: Coastal Plain 1002 Area Environs: FWS-sponsored, Funded or Conducted Studies Gray Literature Search
To: Sarah Conn <sarah_conn@fws.gov>, Patrick Lemons <patrick_lemons@fws.gov>
Cc: Ryan Wilson <ryan_r_wilson@fws.gov>, Christopher Putnam <christopher_putnam@fws.gov>, Susanne Miller <susanne_miller@fws.gov>, Jenifer Kohout <jenifer_kohout@fws.gov>

Hi there,

Please see John's email below. While the request is specifically for the refuge to identify any studies they may have completed, I'm not sure if the FBX off or the MMM office have conducted any studies within the 1002 area that fits this request. Please check with your folks and send me anything you may have.

Thank you!

Drew Crane
Regional Endangered Species Coordinator
Alaska Region
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503
907-786-3323

---------- Forwarded message ----------
From: **Martin, John** <john_w_martin@fws.gov>
Date: Thu, Feb 8, 2018 at 9:29 AM
Subject: Coastal Plain 1002 Area Environs: FWS-sponsored, Funded or Conducted Studies Gray Literature Search
To: Christopher Latty <christopher_latty@fws.gov>, Stephen Arthur <stephen_arthur@fws.gov>, Greta Burkart <greta_burkart@fws.gov>
Cc: John Pearce <jpearce@usgs.gov>, John Trawicki <john_trawicki@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, Joanna Fox <joanna_fox@fws.gov>, Stephanie Brady <stephanie_brady@fws.gov>, Drew Crane <drew_crane@fws.gov>, Wendy Loya <wendy_loya@fws.gov>

Chris, Steve and Greta

There has been a request by the RD via HQ to identify any literature, i.e., resources studies that were conducted wholly or in-part by the Service, specifically not retrievable to the general public as published or peer-reviewed. This may include annual, interim or other documents under the larger umbrella of "gray literature," but not those connected to documents that are published in their final form, i.e., an interim report that when complete is made available to the public or published in a journal. Another category of gray literature are masters thesis or doctoral dissertation that are not formally published. Funding sources may vary, either direct by the Refuge or from other sources such as grants, that inlcude study on the Refuge or parts thereof.

Eric Taylor indicated that there may be some bird studies that may fit this category and have not been included in the USGS literature reviews to date: Douglas et al. (2002); Devaris (2018); or Pearce et al. (2018). The primary focus is on studies since 2002 but should not exclude going back further and possibly all the way back to the start of the initial 1002(d) resource assessments (Clough et al. 1987).

Additionally, there may be other citations for other resources - biological or physical, particularly water resources.

As with other data calls recently this is high speed, low drag and needs to be completed by COB Fri 16 Feb 2018, therefore, submission of anything you may have should be sent to me by **COB Wed 14 Feb 2018**.

And yes, I am going through the ServCat and RefShare databases, but you and staff may know what studies might be included better than I.

Thanks for your time and attention on this matter.

John

Literature Cited

Clough, N.K., P.C. Patton, and A.C. Christiansen. 1987. Arctic National Wildlife Refuge, Alaska, coastal plain resources assessment: report and recommendation to the Congress of the United States and final legislative environmental impact

statement (2 Volumes). Washington, D.C.: U.S. Department of the Interior, Geological Survey and Bureau of Land Management.

Devaris, A. 2018. Bibliography of USGS research conducted in the Arctic National Wildlife Refuge (ANWR) 1002 Area and/or the National Petroleum Reserve - Alaska (NPRA). Information/briefing memorandum dated 19 January.

Douglas, D.C., P.E. Reynolds, and E.B. Rhodes. 2002. Arctic Refuge coastal plain terrestrial wildlife research summaries. Reston, VA: U.S. Department of the Interior, Geological Survey Biological Science Report USGS/BRD/BSR-2002-0001.

Pearce, J.M., P.L. Flint, T.C. Atwood, D.C. Douglas, L.G. Adams, H.E. Johnson, S.M. Arthur, and C.J. Latty. 2018. Summary of wildlife-related research on the coastal plain of the Arctic National Wildlife Refuge, 2002-17. Reston, VA: U.S. Department of the Interior, Geological Survey Open-file Report 2018-1003.

From:	Reed, Jennifer
To:	Steve Berendzen; Joanna Fox; Hollis Twitchell
Cc:	Fischbach, Tracy; Roger Kaye
Subject:	RA: Aligning assigned team lead tasks using effective terminology
Date:	Thursday, February 8, 2018 4:56:58 PM

We've tried to find Hollis to get his input to the discussion with no luck, but Tracy communicated concerns Roger, Tracy and I share to John Trawicki, and John just called me further clarifying that it's up to us to order discipline subjects relating to human dimensions within the RA project's most current Interagency Teams table.

In the spirit of "no surprises," Tracy and I will continue our assignments assuming the following organizational breakdown:

- One main category, "Human Dimensions," should encompass the following sub-headings:
    - Cultural Resources and Historic Background (Ed)
    - Socioeconomic (Jen and Tracy--but see note below)
    - Visitor Use (Jen and Tracy)
    - Subsistence Use (Hollis) (revised name reflects the actual data need more accurately, as opposed to "Subsistence Resources and Lifestyle")
    - Public Health (Sara Longen)
- This list of sub-headings omits the "Public Use" category, which is a composite term that includes visitor and subsistence uses, and therefore would be redundant)

The Socioeconomic subheading, though assigned to Tracy and Jen, will be submitted documenting that our agency has no data for this sub-category because no one in our region has no expertise in this area. John T. expects that in such instances, it's important to simply document so much.

I'm around tomorrow if you feel the need to touch base but if it makes sense to you we can just proceed on this course.

-Jen

---------- Forwarded message ----------
From: **Reed, Jennifer** <jennifer_reed@fws.gov>
Date: Tue, Feb 6, 2018 at 1:30 PM
Subject: Proposed Re-ordered Human Dimensions categories
To: Roger Kaye <Roger_Kaye@fws.gov>, "Fischbach, Tracy" <tracy_fischbach@fws.gov>

Tracy, Roger and I agreed that a need separate from, and prior to, the RA assignments, will benefit the progress of our tasks. Tracy will discuss with John Martin and John Trawicki; and Roger will discuss with Steve Berendzen the following:

Regarding Coastal Plain 1002 Area, Arctic NWR, Resource Assessment Needs Team document:

Reframe the last seven discipline subjects on the Teams document as follows:

Wilderness is not a composite resource; don’t need to repeat what is in all other sections; Wilderness needs to be addressed in each of the sections; Roger can make available to other leads this wildness/wilderness context primer

Name remaining six as Human Dimensions, not “Socioeconomic” and Subsistence Resource & Lifestyle (while throw out term “lifestyle”)
Human Dimensions includes:
National Interest in Arctic Refuge (addresses public perceptions about wilderness characteristics)
Cultural Resources and Historic Background
Public use (access to resource)
Subsistence use (NOT subsistence *resources*, resources under biological)
Local resident / non-subsistence use
Visitor use
Socioeconomic

- Public Health (if no more than food security put with Subsistence,)
- Tourism value to economy

From:	Churchwell, Roy
To:	Christopher Latty
Subject:	Re: Resource Assessment
Date:	Thursday, February 8, 2018 5:15:58 PM
Attachments:	REPORTING TEMPLATE Birds_CL_RC_DP_2-8-18_CL.docx

Chris,

I could probably read it again, but I think I hit the points you were looking for and made a few grammatical corrections.

Roy

On Wed, Feb 7, 2018 at 9:37 PM, Christopher Latty <christopher_latty@fws.gov> wrote:

> Latest. Please take a look and edit/comment/critique when you get a chance.
> --
> Christopher Latty
> US Fish and Wildlife Service
> Arctic NWR
> 101 12th Avenue
> Room 236
> Fairbanks, AK 99701
> cell 907-347-4300

--
Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
101 12th Ave. Room 206
Fairbanks, AK 99701
(907) 456-0450
https://www.fws.gov/refuge/kanuti/

REPORTING TEMPLATE

Discipline/Subject Area: Birds

What do we need to know and why regarding subjects?

1) Determine contemporary distribution, habitat use, abundance, and phenology of breeding, and post-breeding birds in the 1002 Area.
2) Understanding of baseline factors limiting the population size of birds in the 1002 Area.

What information is currently available to address the information needs for subjects?

Contemporary distribution and abundance (since 1990)

Numerous site specific surveys were conducted in the late 1970s through mid-1980s in the 1002 Area, including ground based tundra breeding bird surveys on the coast and inland , breeding and post breeding bird surveys on barrier islands and lagoons, aerial breeding swan surveys, breeding raptor surveys in the mountains and along rivers, and post-breeding snow goose surveys. Although these data provide important historic abundance and habitat use, abundance and distribution of many of the most common and at-risk birds using the 1002 Area have changed, in some cases dramatically, as the Arctic has warmed over the last 40 years and birds have been impacted by habitat changes on migration routes and wintering areas. Therefore, the data from these earlier surveys may not represent bird populations today in the 1002 Area.

More recent data to address information needs include:

Breeding

- Shorebird ground-based surveys were conducted using the Program for Regional and International Shorebird Monitoring (PRISM) protocol during the summer in 2002 and 2004 to determine breeding abundance and distribution. Survey sites were selected randomly within wet and dry strata each year but the number of survey sites were moderate to low, and some species were observed in such low numbers that distribution and abundance estimates are unreliable. This project found higher shorebird density in wetlands compared to other habitat types and in locations near the Canning River Delta.
- Aerial and ground-based breeding bird surveys to determine abundance and distribution (primarily for common eider) were conducted on barrier islands in 1999-2009 and 2003/04 and 2014-17, respectively (2003/04 and 2015 were the only years in which most of the 1002 Area islands were surveyed). A dramatic increase in the number of common eider breeding on Refuge barrier islands was reported (14, 177, 382 active nests at discovery in 1976, 2003/04, and 2015; 341 and 825 total nests (Pearce et al. 2018) in 2003/04 and 2017, respectively).
- Breeding cliff-nesting raptors were periodically surveyed in the Brooks Range, foothills, and 1002 area a few times in the 1990s and early 2000s. Overall abundance of raptor nests was generally low in the 1002 Area, but the only year that most rivers offering suitable habitat were surveyed was 1992.

- Annual aerial surveys of waterbirds, including waterfowl, loons, larids, and skuas, were conducted across much of the Arctic Coastal Plain (ACP) of northern Alaska, including parts of the 1002 Area beginning in 1986. However, only about one-fourth of the 1002 Area is included in this survey, and what is surveyed falls within the low-density strata, leading to overall coverage of less than one half of one percent.
- Point counts were conducted on a few days in June of 1993 on Barter Island as a pilot for estimating landbird abundance, but not repeated thereafter.

Post-breeding

- Boat and ground-based coastal shorebird surveys were conducted during fall staging and migration at the major river deltas, 2006 – 2011. Only surveys in 2010 and 2011 at the Jago, Okpilak/Hulahula, and Canning included surveys often enough to capture the peak numbers of migrants. Other year and surveys conducted at other deltas were conducted once or twice, when the peak numbers of birds were expected; however, the peak was often missed. From the complete surveys we understand that the Jago is an important delta for staging and migrant bird early on, but later on large numbers of birds can us the Okpilak/Hulahula and Canning deltas as well.
- Aerial fall-staging snow geese surveys occurred in 1992-93, 1997-2001, 2003-04. Up to 325,000 snow geese have been estimated to be using the Arctic Refuge coastal plain. Lagoon surveys of post-breeding and molting waterbirds were conducted in 1999-2003.
- Tundra swan surveys were conducted in 1990.
- Breeding adults of 3 species of shorebirds were tagged in summer 2017 at 4 sites on the ACP with GPS loggers to track use of stopover sites along the Beaufort Sea coast. Additional tagging of 3 more species is planned for 2018. Although this data will help inform where and how adult shorebirds use the ACP during pre-migration, tagging of more individuals and species are needed before thorough assessments can be completed.

Commented [LCC1]: Roy – please add any issues with these surveys that would warrant worrying about their accuracy. Also please add a sentence or 2 about the highlights of the results.

Local distribution and abundance for sites identified as important in broader surveys

- The only long-term or contemporary fine spatial scale breeding bird data for the 1002 Area is a single site at the Canning River Delta. Intensive site-specific surveys focused on shorebird breeding abundance were conducted at the Canning River in 1979-80, 2002-2007, 2010-2011. Some waterbird and passerine abundance data were also collected. More expansive surveys of waterfowl and other waterbirds were conducted in 2017. This site has provided significant information on the fine scale habitat use patterns and phenology of tundra nesting shorebirds, passerines, waterfowl, and loons breeding specifically in the 1002 Area. It has also provided specific information on abundance shifts for some of the more common species breeding in the 1002 Area. For example, the density of nesting cackling geese appears to have increased nearly 20 fold at the study site since 1980.

Phenology

- A large amount of information is available for the timing of breeding for tundra nesting birds for the ACP (e.g, arrival to breeding grounds, nesting, and brood-rearing). Therefore, breeding phenology in the context of informing minimization of disturbance to nesting birds in the 1002 is probably adequate.
- We also have reasonably good data for the timing of pre-migration and migration for several species for the ACP, including molting sea ducks in the lagoons, staging juvenile shorebirds along the river deltas, and staging snow geese on the tundra. Additionally, we have some recent telemetry data for loons from sites further to the west on the ACP that may be applicable to loons breeding on the Refuge and some adult shorebirds tracking data from several locations on the ACP xx.
- Adults of a few species were tagged in summer 2017 with GPS loggers to track their movements and core stopover sites, more individuals and species are needed before assessments can begin
- As part of the ongoing project described above, data on the phenology of pre-migration breeding adult shorebirds is currently being gathered through tagging, although more individuals and species are needed before thorough assessments can be completed.

Commented [LCC2]: Roy – can you add something here if Audrey's work would fit in.

Limiting factors

- Numerous studies on the effects of development and disturbance on nesting birds have been conducted in Prudhoe Bay and NPR-A since the 1970s. Additionally several studies on the potential impacts of industrialization and disturbance were conducted in the 1002 Area. These studies greatly enhanced our understanding of potential impacts, but previous work was often limited by the number of man-hours that could be applied to answer complex ecological questions. Results of specific projects can be found in the summaries, including the Arctic National Wildlife Refuge Coastal Plain Resource Assessments and Updates (e.g., Garner and Reynolds 1986), Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries (Douglas et al. 2002, Pearce et al. 2018), and the National Research Council report on the cumulative environmental effects of oil and gas activities on Alaska's North Slope (National Research Council 2003).

Commented [LCC3]: There could be 3 pages just listing these studies and some basic results. I don't think we should get into that level of detail here as the document is already going to be longer than what I think the RO desired. I suggest this remain very very vague. Thoughts?

Much of the data from these surveys are not currently generally available electronically. Arctic Refuge is currently working with FWS Science Applications to build a publically accessible database for the Canning River Delta tundra nesting bird data. Similar work should occur in the future to build robust databases to house complex data collected across decades in the 1002 Area at different resolutions and to meet the specific objectives of individual research projects. Because protocols or how data were collected varies slightly between projects, careful analysis of the differences and similarities must occur for the data to be comingled.

Commented [LCC4]: Still needs some streamlining.

What are key information gaps?

Contemporary distribution and abundance

Breeding

- Most of the current information on breeding bird distribution and abundance in the 1002 Area is dated, only collected for one or two years, covers only a small portion of the site, and/or was collected at very low survey intensity. The only area where we have adequate current data is for birds breeding on 1002 Area barrier islands. Given large declines in many shorebird species, large increases for some goose species, and potential changes to 1002 Area habitat due to climate change, it is essentially to gather more contemporary data over several years at the appropriate spatial intensity. New statistically-rigorous surveys will allow identification of key areas and habitats used by birds. Because the 1002 Area contains far fewer waterbodies compared to further west, like NPR-A, it is likely the bird distribution is spotty with some heavily used, high quality habitats intermixed with broad areas of low bird density.

Post-breeding

- The current information on non-breeding bird distribution and abundance in the 1002 Area is dated, except for juvenile shorebirds use of river deltas for fall staging. Given the same issues described above for breeding birds (e.g., large fluctuations in overall ACP abundance for many species and potential changes to 1002 Area habitat due to climate change) it is essentially to gather more contemporary data for non-breeding bird use of the 1002 Area over several years at the appropriate spatial intensity. These efforts should be focused on identifying key areas for staging adult shorebirds, determining current distribution of molting sea ducks in the lagoons and if the distribution of staging snow geese is similar to historic distributions.

Local distribution and abundance for sites identified as important in broader surveys

- The long-term breeding ecology study site at the Canning River Delta is on the western edge of the 1002 Area. Although significant insight has been gained about shifts in abundance for this area, little is known about changes in abundance at other key breeding sites in the 1002 Area. Survey plots were established at numerous locations in the 1980s and should be resurveyed to acquire current fine-scale breeding bird density estimates for central and eastern portions of the 1002 Area. These data will not only provide updated abundance, but will also allow for evaluations regarding shifts in habitat use that may be significant when designing larger-scale surveys

Phenology

- Phenology information for most breeding birds in the 1002 and for post-breeding juvenile shorebirds is adequate, but a changing climate may impact these estimates in future years. Therefore, semi-regular assessments of these groups should continue. While the information for post-breeding bird use of the lagoons and use of the tundra by staging snow geese is somewhat dates, a few years of surveys to examine for changes in phenology would sufficiently address this. The primary data gaps for bird phenology remaining are for arrival and use of the lagoons by staging water birds in the spring, use of the coastal plain by raptors in spring, and post-breeding use of coastal areas by adult shorebirds. Although traditional surveys may fill some of these, new

Commented [CRT5]: This doesn't quite fit. I think you have a different subject to the sentence than you are referencing here.

Commented [LCC6]: This still needs more thought out and provide a more succinct rationale about the importance these fine scale surveys.

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remote tracking technologies may provide more detailed information better suited to inform fine scale management of these areas.

Limiting factors

- Before a thorough analysis of potential limiting factors that may be impacted by development can be completed, we first need to better determine the distribution, habitat use, abundance, and phenology of breeding, and post-breeding birds in the 1002 Area.
- There are also major differences in water availability between NE AK coastal plain (1002 Area) and areas further west (e.g., Prudhoe Bay and NPR-A). Impacts to the availability, seasonality, or flow of water on the 1002 Area could have a different impact on birds, their habitats, and their foods compared to elsewhere because of this availability. There is currently an information gap in how this underlying difference in water in the 1002 Area may lead to differential impacts to birds in the 1002 Area and how studies conducted in areas with greater densities and more consistent distribution of waterbodies in the western ACP (e.g., Prudhoe Bay and NPR-A) may be impacted by this.
- Changes in the avian predator community makeup, abundance, and impact to productivity have been the most commonly described consequences of industrial activity for birds breeding on the ACP. Decreased nest survival has been reported for ground nesting passerines and waterfowl on the Alaskan North Slope. In Prudhoe Bay, red fox displaced Arctic fox at dens near industrial facilities. Although shifts in the distribution of red foxes into areas previously dominated by Arctic foxes have been documented over wide areas of the circumpolar North, red fox are thought to take advantage of anthropogenic corridors; therefore, winter exploration may exacerbate this effect. This is important because the two species appear to prey on bird nests quite differently. In a 2017 pilot study, we found that red foxes predominantly depredated waterfowl nests and Arctic foxes depredated shorebird nests. Although this and the data collected on nest predation on the barrier islands has been broadly informative, there appears to be large inter-annual variation in predation pressure, potentially related to annual changes in alternative prey abundance. Therefore, additional years of data collection to identify the primary predators of bird species groups is required, as is information on predator abundance. We also do not have data on predator species densities or any predator data for tundra nesting birds outside the Canning River Delta.
- x

Commented [LCC8]: I really would like to include something about predators here, but I'm not sure how well it fits without more thorough discussions of other limiting factor gaps. Thoughts?

Commented [LCC9]: Do we include others? Thoughts?

Commented [CRT10]: What about toxins/chemicals?

What studies/surveys need to be conducted to fill those information gaps?

- Conduct intensive breeding season aerial waterbird surveys throughout the 1002 Area to provide information on waterbird distribution and abundance and to identify areas critical to waterbirds breeding in the 1002. These surveys should be structured to provide complete coverage, but survey intensity stratified based on habitat and prior data.
- Conduct ground-based nesting bird surveys throughout the 1002 Area during the breeding season to provide shorebird and landbird distribution and abundance

estimates. These surveys should be structured to provide complete coverage, but intensity stratified so additional effort is based on previously identified important habitats, and if known, focus on sites of future oil and gas development.

- Conduct ground or aerial surveys of Brooks Range and foothill rivers for cliff-nesting raptor nests.
- Conduct an assessment of the importance of the 1002 Area to Brooks Range and foothill rivers for cliff-nesting raptors using tracking devices.
- Conduct post-breeding surveys to determine distribution and abundance of shorebirds and sea ducks along the coastal lagoons and snow geese on the tundra. To address questions of residency time and phenology, attach tracking devices to a cohort of these birds.
- Conduct tagging studies of key waterbird and adult shorebird species to determine important post-breeding sites and phenology. Recently, miniature GPS tags have been developed for shorebirds and waterfowl that greatly increase both the spatial and temporal resolution of habitat use by birds. These tags should be used to increase our knowledge of habitat use in the 1002 Area, especially for poorly understood species, but also to provide high-resolution phenology data for birds in the 1002 Area during migration.
- Continue and expand studies on avian and mammalian predators, with particular emphasis on subsidized predators such as Arctic fox, red fox, gulls, and ravens. Again, new remote sensing technologies like cameras and tracking devices should be used to increase the resolution of information about prey preferences and movement patterns of predators in relation to anthropogenic stressors. Studies should be done before, during, and after oil and gas development has occurred.
- Continue and expand studies on the limiting factors of the predominant and at-risk bird species in the 1002 Area.
- Investigate what happens to birds that are displaced from habitats being converted to oil and gas infrastructure by conducting long-term tracking studies, using both marked individuals and solar-powered satellite tags.

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From: Twitchell, Hollis
To: Vince Mathews
Subject: Draft Resource Assessment - Subsistence Uses
Date: Friday, February 9, 2018 1:41:01 PM
Attachments: 1002 Subsistence Resource Assessment Template.docx

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Draft assessment still underway, your thoughts? Recommendations?

--
Hollis Twitchell
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Arctic Refuge
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2018 Coastal Plain 1002 Interdisciplinary Resource Assessment

REPORTING TEMPLATE

> **Subsistence Use**:

> **Lead facilitator** Hollis Twitchell, Arctic Refuge Assistance Manager, 456-0512

> **Individuals contacted** : [may include individuals, teams, institutions or organizations] Nicole Hayes, BLM; Stacey Fritz, BLM; Vince Matthews, FWS; ADF&G Division of Subsistence; NSB Department of Wildlife Management.

> **What do we need to know and why regarding subjects?**

Demograhics and Subsistence

Kaktovik located on Barter Island is the only settlement near the 1002 area. It is an Iñupiat coastal community with a high dependence upon marine and inland resources for subsistence harvests. In 2010, Kaktovik's population was 239 persons with early 90 % of the population being of Native Iñupiat decent (Alaska Census Data, 2010). Participation in subsistence activities by Kaktovik households is high with 95.7 % of households using subsistence resources (ADF&G 2010). The subsistence way of life encompasses much more than just a way of obtaining food or natural materials. It involves traditions which are important mechanisms for maintaining cultural values, family traditions, kinships, and passing on those values to younger generations (Alaska Federation of Natives 2005). It involves the sharing of resources with others in need, showing respect for elders, maintaining a respectful relationship to the land, and conserving resources by harvesting only what is needed. Subsistence is regarded as a way of life, a way of being, rather than just an activity (Alaska Federation of Natives 2005).

Mixed Subsistence and Market Economies

Modern mixed subsistence-market economies require cash income sufficient enough to allow for the purchase of this mechanical equipment (boats and motors and snow machines) as well as the operational supplies such as fuel, oil, maintenance parts and equipment, firearms, ammunition, nets and traps, etc. Subsistence is not oriented toward sales, profits, or capital accumulation but is focused toward meeting the self-sustaining needs of families and small communities (ADF&G 2000). Participants in this mixed economy supplement their subsistence harvests by cash employment from construction jobs, oil and gas industry jobs, commercial fishing, Alaska Permanent Fund or Native Corporation dividends and/or wages from the public or government services sectors. In Kaktovik, major employers are the North Slope Borough, City of Kaktovik and the Kaktovik Iñupiat Corporation. There are also a few private sector jobs and business such as grocery stores, motels, air carrier services and recreational wildlife viewing and boat transportation providers. Tourism has begun to develop with increasing interest in viewing polar bears, observing traditional whale harvest activities, and participating in other recreational activities. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987). Subsistence harvests of natural resources provide both nutritional sustenance and cultural and social well-being strengthening family and community social ties and their Iñupiat cultural identity.

Resource Seasonality and Access

The community's harvest of subsistence resources can fluctuate widely from year to year because of variable seasonal migration patterns of marine mammals, fish, waterfowl and game. And because subsistence harvesting techniques are extremely dependent on changing weather and ice at sea and snow and ice conditions on land dramatically affecting ability to access resources. Determining when and

where a subsistence resource will be harvested is a complex activity due to variations in seasonal distribution of animals, migration patterns, extended cyclical variation in animal populations and ever changing and complex hunting regulations. Human factors such as timing constraints (due to employment or other responsibilities), equipment (or lack thereof) to participate, and hunter preference (for one resource over another or for one sort of activity over another) are important components in determining the overall community pattern of subsistence resource harvest.

Subsistence Uses and Development Conflicts

During the January 12, 2010, Public Scoping Meeting in Kaktovik for the Point Thomson Project EIS, subsistence users of the community expressed significant concerns regarding impacts from development of facilities, pipelines, roads, aircraft and operations which could displace caribou and other important species away from coastal areas where subsistence harvesters could access them. In citing past history regarding the original Point Thomson drilling project they said there were many restrictions to subsistence hunting around the project area and they now question how close subsistence hunters will be allowed to hunt near the drill pads, pipeline, and other facilities, and what new restrictions will be placed upon subsistence users.

Barging and fuel spills continue to be a major concern as well as the grounding of barges extending a significant distance from shore for lengthy periods of time. This they believe will affect movement of seals and various species of fish which migrate through the area. There are further concerns about the exploration, production and scale of development, and the cumulative impacts of future development over time of other off-shore and inland fields, resulting in an even larger scale of impacts upon their subsistence resources and subsistence use opportunities.

The issue of noise impacts to users was raised as Kaktovik people travel and camp in the area of proposed development. Commenters stated that helicopter and aircraft traffic above ground and pipelines, roads and facilities on the ground would result in combined impacts likely to drive caribou away from the coastal areas they hunt. Questions were raised on how many ice roads, gravel roads and how much traffic is going to be on these roads and what times of the year.

Flaring from wells will contribute to environmental pollution…….

[i.e., what decisions or determinations are required; what are the conservation threats; address what we know about the resources in the area - distribution, abundance, seasonal movements; how they may be impacted by oil and gas development; what mitigation measures available and their effectiveness, subsistence activities?]

> **What information is currently available to address the information needs for subjects?** [include citations – may want to refer to pending USGS annotated literature review?]a

Species Harvest Patterns

Marine Mammals - Whaling resumed in Kaktovik in 1964. In years when Kaktovik residents harvest and land a whale, marine resources have composed 59 to 68 % of their total subsistence harvest. Bowhead whaling occurs between late August and early October, with the exact timing depending on ice and weather conditions (Minerals Management Service 2003). There are at least 10 whaling crews in Kaktovik, and the community has a quota of three strikes (whether the animals are landed or not). Kaktovik has what is essentially an intercommunity agreement with Anaktuvuk Pass under which muktuk, whale meat and other marine mammal products (especially seal oil) are sent to Anaktuvuk Pass and

caribou and other land mammal products are sent from Anaktuvuk Pass to Kaktovik (Bacon et al. 2009). Caribou is a much more variable resource for Kaktovik than for Anaktuvuk Pass, and Anaktuvuk Pass does not have access to bowhead whales or other marine mammals. Other marine mammal hunting (mainly seals) can take place year-round. Kaktovik residents also harvest a significant number of bearded and smaller seals, and the occasional beluga whale or polar bear.

Terrestrial Mammals - Land mammals are the next largest category of harvest, ranging from 17–30 percent in those same years. The primary land mammal resource is caribou, but Kaktovik residents also harvest a significant number of Dall's sheep. Of lesser abundance and availability are muskox, moose and grizzly bears. While Kaktovik hunters have taken moose and muskox, harvest opportunities are significantly restricted due to their low population numbers. Kaktovik's annual caribou harvest fluctuates widely because of the unpredictable movements of the herds, weather-dependent hunting technology, and ice conditions. Caribou hunting occurs throughout most of the year, with a peak in the summer when open water allows hunters to use boats to access coastal and river areas for caribou.

Fishery Resources - Fish comprise 8–13 % of the total subsistence harvests. Fish may be somewhat less subject to these variable conditions but still exhibit large year-to-year variations. In some winter months, fish may provide the only source of fresh subsistence foods. Kaktovik's harvest effort seems to be split between Dolly Varden and whitefish, with the summer fishery at sites near Kaktovik being more productive than winter fishing on the lower reaches of the Hulahula River.

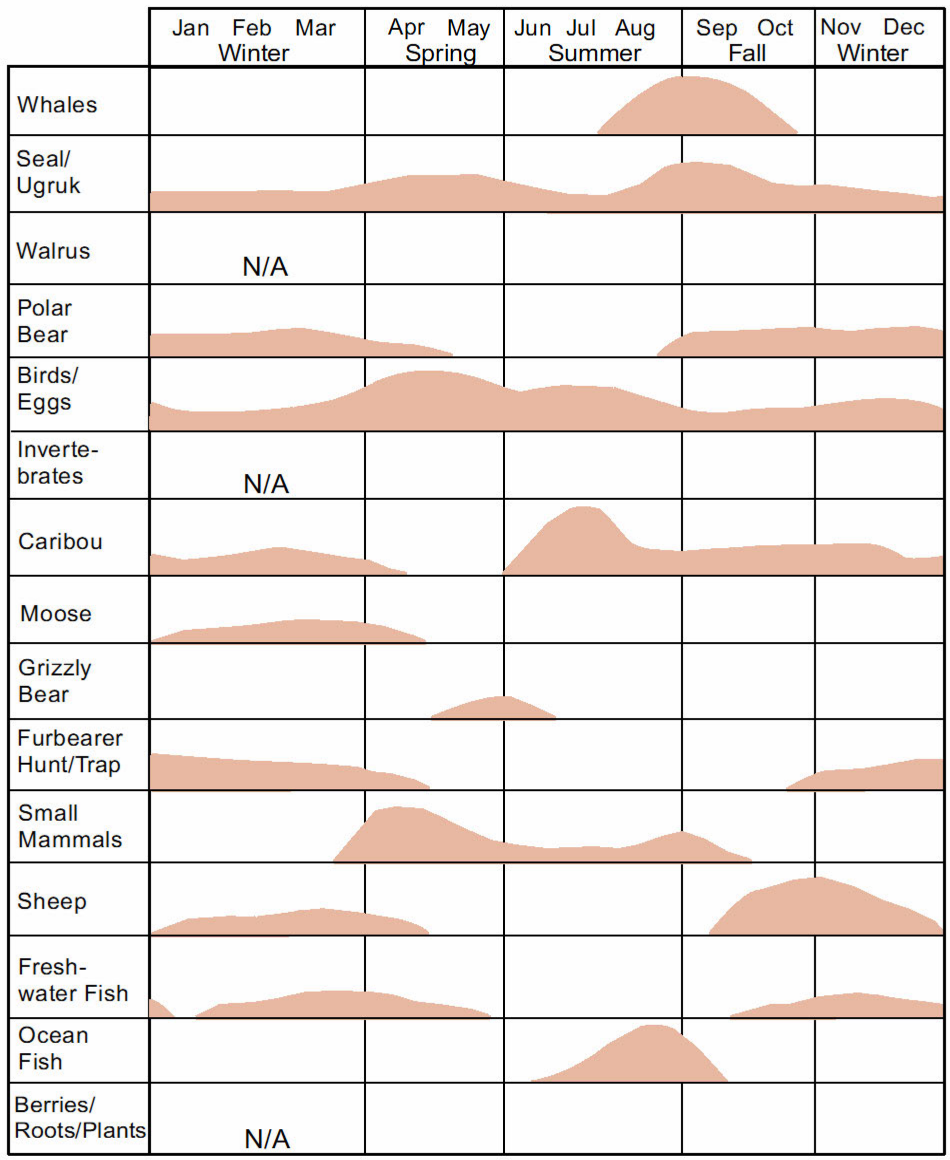
Bird Resources - Birds and eggs making up 2–3 % of the total harvest. Since the mid-1960s, subsistence use of waterfowl and coastal birds has been growing at least in seasonal importance. Most birds are taken during the spring and fall migrations. Important subsistence species are black brant, long-tailed duck, eider, snow goose, Canada goose, and pintail duck. Waterfowl hunting occurs mostly in the spring from May to early July (Minerals Management Service 2003). Ptarmigan are also a seasonally important bird.

Furbearer Resources - Trapping of furbearers in the Kaktovik area has decreased with time. Furbearers are taken in the winter when surface travel by snowmachine is possible. Hunters pursue wolf and wolverine by searching and harvesting them with rifles primarily between March and April or in conjunction with winter sheep hunting. Some hunters may go out in the fall or early winter, but usually weather and snow conditions are poor at that time and people are more concerned with meat than with fur.

……

2015 Arctic National Wildlife Refuge CCP Final EIS: Table 4-26

Annual Subsistence Cycle for Kaktovik (qualitative presentation).



Source: Galginaitis et al., 2001; based on Wentworth 1979

Note: Patterns indicate desired periods for pursuit of each species based on the relationships of abundance, hunter access, seasonal needs, and desirability. Heights of graphs indicate level of effort.

Subsistence Harvests Data

Community subsistence harvest data for Kaktovik is somewhat dated in terms of the in-depth subsistence community use surveys, which were conducted in 1985, 1986, 1992 (ADF&G). In 1995, the North Slope Borough (NSB) began to systematically collect subsistence harvest data for the eight villages in the

Borough. However, the NSB was only able to collect subsistence harvest data for the village of Kaktovik in 1994-1995 and in 2002-2003.

Subsistence harvest studies for Kaktovik in 1995 indicated that 61% of the subsistence harvest (in edible pounds of food) were from marine mammals, consisting of bowhead whales, bearded seals, ringed seals, spotted seals, polar bears, and beluga whales. Terrestrial mammals comprised another 26% of the estimated edible pounds harvested, consisting of caribou, Dall's sheep, muskox, moose, and brown bear. Fishery resources accounted for 11% of the estimated total edible pounds of harvest. Seven species of fish accounted for the 4426 fish harvested of which Arctic Cisco and Dolly Varden represented 4233 of the fish caught. The harvest of birds accounted for the remaining 2% of edible pounds of subsistence harvest with 530 birds reported harvested (Brower et al 2000).

In the 1995 study, thirty-one different species were reported harvested with key species being caribou and Dall's sheep for terrestrial mammals; bowhead whales, ringed and bearded seals for marine mammals; brant and ptarmigan for birds; Arctic Cisco and Dolly Varden for fish; and wolf and ground squirrels for furbearers.

In addition to the Beaufort Sea, Kaktovik residents have access to a number of rivers and lakes which support significant subsistence fish resources. Pedersen and Linn (2005) conducted surveys of the Kaktovik subsistence fishery in 2000-2001 and 2001-2002, with estimated community harvests of fish at 5,970 pounds and 9,748 pounds, respectively. Dolly Varden, lake trout, and Arctic Cisco were the only fishery resources reported harvested by Kaktovik households in this study. Dolly Varden was the most commonly harvested fish in terms of numbers harvested and estimated harvest weight, with Arctic Cisco and lake trout ranking second and third (Pedersen and Linn, 2005).

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….

> **What are key information gaps?**

Currently there is no complete synthesis of cultural work (subsistence, historical, archaeological) that has been conducted in the Arctic Refuge as a whole or in particular for the northern half of the Refuge. A limited number of archeological and historical resource surveys have taken place on the Refuge due to funding, logistical difficulties of working in remote locations and lack of infrastructure to support investigations in the Refuge. A more through and complete synthesis of what work has been completed and in what areas would help identify informational gaps and help set priorities for future work.

In 2010, Morgan Grover of the US Army Corps of Engineers conducted a survey of 70 known cultural sites along the coastal areas from Flaxman Island to the Canadian border (including the 1002 area) to examine the effects of environmental changes and erosion has had on these sites over the past 30 years. The study concluded that of the 69 previously reported cultural sites, 21 were found to have been impacted to some extent by erosion or thermokarsting, and 20 had been completely eroded away. She concludes that many of the remaining cultural sites are in imminent threat of eroding in the next decade. Follow-up studies and research is needed to recover cultural information before it is lost to erosion. The report strongly recommended that selected threatened sites be documented and potentially excavated after consultation and agreement with Tribal leaders.

In 2010, Jake Anders conducted a brief archeological survey in the eastern end of the Sadlerochit Mountains just outside and south of the 1002 area. Nine archeological sites were located, 8 of which have not been previously reported. The discovery of these sites has greatly increased the number of known archeological sites in this particular area of the Refuge, and suggests that the pre-contact indigenous land use of the northern foot hills of the Brooks Range was more intense than has previously been thought. There is a need to conduct further cultural resources surveys within the uplands and hills of the 1002 area.

In 1982, Ed Hall conducted and inventory and survey of archaeological and historical resources in the 1002 area examining areas of high archaeological and historical potential. The areas surveyed were focused on areas proposed for exploratory drilling for oil and gas and areas more likely to have cultural sites such as coastal areas and barrier islands, and along rivers and streams that crossed the 1002 area, and high points of land that have overlooks above the surrounding tundra. There is a need to reassess these areas since visitors and users have reported several graves, human remains the artifacts in these areas that have not been documented and record by professional cultural resource staff.

> **What studies/surveys need to be conducted to fill those information gaps?** Please include duration (start and end), staffing and cost estimates.

From: Burkart, Greta
To: Christopher Latty; Stephen Arthur; Roy Churchwell; Lanctot, Richard
Subject: draft resource assessment for water
Date: Sunday, February 11, 2018 2:46:46 PM
Attachments: 02112018_Water Resources.docx

Hi Everyone,

I have attached a draft of the resource assessment for water resources. This draft incorporates comments from Jeff Conway at USGS. We expect additional comments from staff at BLM.

Let me know if you have any comments on the document or about how we can collaborate aquatic work with bird surveys.

Thanks,

Greta

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Discipline/Subject Area: Water Resources

Lead facilitator (name and contact information): Greta_Burkart@fws.gov (907-750-7067), Aquatic Ecologist, Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program; John_Trawicki@fws.gov (907-786-3474), Water Resources Branch Chief, National Wildlife Refuge System, Alaska

Individuals contacted (or who needs to be contacted if unavailable): Margaret Perdue (USFWS Water Resources Branch), Jeff Conway (USGS), Richard Kemnitz (BLM), Alan Peck (BLM)

What do we need to know and why?

The Alaska National Interest Lands Conservation Act (ANILCA) explicitly directs the Service to ensure water quality and quantity for the conservation of the natural diversity of fish, wildlife and their habitats.

(i) to conserve fish and wildlife populations and habitats in their natural diversity……

(iv) to ensure, to the maximum extent practicable and in a manner consistent with the purposes set forth in paragraph (i), water quality and necessary water quantity within the refuge.

To ensure mandates are met:

- Identify high value aquatic habitats and hydrologic processes by season to ensure sufficient water is available to meet refuge mandates
- Evaluate the efficacy, applicability and transferability of best management practices (BMP) and mitigation measures used in the development of the National Petroleum Reserve - Alaska (NPR-A) for use on the coastal plain, 1002 area (National Research Council 2003) for all phases (seismic, exploration, development, restoration) of oil and gas operations
- Recognize and understand the impacts of the stark hydrologic and topographic differences between developed areas of the NPR-A and the coastal plain, 1002 area:
    - Approximately 21% of the surface area of the developed area in NPR-A is water, while water covers less than 2% of the coastal plain, 1002 area where large expanses of land are nearly devoid of lakes
    - Most lakes in the coastal plain, 1002 area are isolated from major drainages and may be more vulnerable to adverse impacts of water withdrawals
    - The terrain of much of the coastal plain, 1002 area is considerably steeper than the NPR-A
    - The majority of flowing waters in the coastal plain, 1002 area are alluvial mountain streams, while beaded tundra streams are more prevalent in the NPR-A
    - Groundwater-fed springs are unique features of the coastal plain, 1002 area and provide critical habitat for large concentrations of invertebrates and overwintering fish.
- Recognizing the limited availability of water, how can habitat and industrial needs be met?

Winter seismic and exploration activity will involve withdrawals of large volumes of water and temporary infrastructure that could have substantial short-term or long-term implications to fish and wildlife populations and habitats and surface water hydrology.

Development and production phases will continue to use large volumes of water with a higher potential for contamination, alteration of surface water hydrology and interaction of surface water and groundwater from the development of pads, roads, and gravel extraction.

What information is currently available to address the information needs?

Most water resource studies were conducted nearly thirty years ago and include the following:

- Streamflow data: five years of continuous hydrologic information for three large rivers (USGS 2018) and seven smaller rivers and streams (Lyons and Trawicki 1994). The only ongoing hydrologic monitoring is on the glacier-fed Hulahula River.
- Water quality data: Single sampling event by USGS in 1975 for a limited suite of parameters on 15 streams and 6 lakes in or immediately adjacent to the coastal plain, 1002 area
- Documentation of sensitive fish species in 6 lakes and documentation of non-sensitive species in 42 lakes (Wiswar and others)
- Lake bathymetry and analysis of winter water availability for 119 of the largest lakes (Trawicki, Lyons and Elliot 1991)
- Winter water availability in large river systems (Elliot and Lyons 1990)
- Elevation of lake surfaces and marginal wetland zones (Bayhas 1996)
- Inventory of lakes that may be deep enough to support overwintering fish (Grunblatt and Atwood 2014)
- Inventory of groundwater springs (Childers et al. 1977)

What are key information gaps?

- What are the impacts of oil and gas activities on surface water hydrology and aquatic habitats?
- What are the locations of high-value fish and waterbird habitats and what seasonal processes supporting these habitats might be impacted by oil and gas activities?
- Which aquatic habitats are most vulnerable to oil and gas impacts?
- How effective are existing best management practices and mitigation measures at ensuring protection of habitat and will they ensure protection of habitat in the coastal plain 1002 area?
- What are groundwater flow paths and recharge rates
- What are baseline water quality characteristics of rivers and lakes?

What studies/surveys need to be conducted to fill those information gaps?

Rivers:

- Evaluate the current status and natural variability in late fall and spring hydrology and water quality in relation to the timing of fish use to provide information necessary for minimizing impacts of water withdrawals. Install continuous water quality gages on representative rivers to characterize seasonality in water quality parameters and define baseline conditions.
- Document the value and extent of overwintering habitat and aufeis. Assess the role of aufeis in supporting fish overwintering habitat and downstream ecosystems on the Canning, Hulahula, Itkilyariak, and Sadlerochit Rivers.
- Evaluate the efficacy of existing best management practices and mitigation measures and the applicability of these measures in the coastal plain 1002 area. Considerations must include effects on sheet flow, ice-dam flooding, and recharge of lakes to ensure protection of natural flow regimes, water quality, and overwintering habitat.

- There is a longer term planning need to define the studies necessary to minimize impacts of gravel extraction and permanent infrastructure in the coastal plain 1002 area where there are substantial differences in hydrology and terrain.

- Develop a conceptual groundwater model for the area and inform this model with isotopic studies to delineate and age flow paths. Quantify recharge rates to inform water withdrawal permits in areas that are primarily recharged from groundwater.

Lakes:

- Prior to seismic exploration, surveys of macroinvertebrates, wet meadow zones, fish, and winter water quality in the coastal plain, 1002 area are necessary to document high-value fish and waterbird habitat and to capture baseline data necessary to manage adaptively. Prior to seismic exploration in the coastal plain, 1002 area, similar surveys should be conducted in NPR-A lakes to assess the efficacy of existing best management practices and mitigation measures (per National Research Council 2003). These surveys should be conducted on untapped lakes and lakes where the entire permitted volume has been withdrawn and the vulnerability is similar to a range of lake types in the coastal plain 1002 area.
- A geospatial inventory of sediment type, hydrologic connectivity, relative depth, and watershed areas is necessary to identify lakes that are vulnerable to adverse impacts of water withdrawal.

Geospatial:

- Cross reference technical reports to identify and map areas of special value including Wild and Scenic Rivers, springs, subsistence use areas, and recreational areas that should be avoided (e.g. Canning River takeout) and identify data gaps in our knowledge of special areas.
- Install continuous water quality gages on representative rivers to characterize seasonality in water quality parameters and define baseline conditions Develop NHDPlus High Resolution hydrography framework, which extends the hydrologic network seamlessly across the terrain by including not only streams, but also associated catchment areas that drain to each stream segment. This association allows information about the landscape to be related to the stream network. Observational data on the stream network, such as water quality samples, streamgage measurements, or fish distribution, can also be linked to the framework.

From:	Martin, John
To:	Decleva, Edward
Cc:	Hollis Twitchell
Subject:	Re: Arctic Plain 1002
Date:	Monday, February 12, 2018 10:22:04 AM

Thanks

On Mon, Feb 12, 2018 at 7:08 AM, Decleva, Edward <edward_decleva@fws.gov> wrote:

> Hi John,
>
> The reporting templates for Cultural Resources and Paleontological Resources have been placed in their respective folders on Google Drive.
>
> Edward J. DeCleva
> Regional Historic Preservation Officer
> U.S. Fish and Wildlife Service, Alaska Region
> 1011 E Tudor Rd, MS-235
> Anchorage, AK 99503
>
> edward_decleva@fws.gov
> 907-786-3399

From:	Harwood, Christopher
To:	Roy Churchwell; Joanna Fox; Tina Moran; Bob Henszey; Susan Georgette; Michael Spindler; Julianus, Erin
Subject:	Moving in the Anthropocene: Global reductions in terrestrial mammalian movements
Date:	Monday, February 12, 2018 10:58:33 AM

Saw reference to this in most recent TWS eWildlifer. Possible citation vis-a-vis 1002, Ambler, etc.?

http://science.sciencemag.org/content/359/6374/466 full

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Christopher Harwood
Wildlife Biologist
U.S. Fish and Wildlife Service
Kanuti National Wildlife Refuge
101 12th Ave.; Room 206
Fairbanks, AK 99701
(907) 455-1836 (w)
(907) 456-0506 (fax)

"In my house, anyone who uses one word when they could have used ten just isn't trying hard."

- Josiah Edward Bartlet, PhD, Nobel Laureate

From:	Burkart, Greta
To:	Jorgenson, Janet; John Trawicki
Cc:	Churchwell, Roy; Arthur, Stephen; Christopher Latty; Payer, David
Subject:	Re: Bibliography
Date:	Monday, February 12, 2018 2:34:48 PM
Attachments:	USFWS publications and reports.xlsx

Hi Everyone,

I have attached a list of citations for all water and fisheries reports and publications by USFWS staff. This list should cover everything from the 1002 Area and a few studies conducted elsewhere on the North Slope.

Greta

Greta Burkart, PhD
Aquatic Ecologist
US Fish and Wildlife Service
Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
101 12 th Ave Rm 236
Fairbanks, AK 99701
ph: (907) 456-0519
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www.facebook.com/arcticnationalwildliferefuge

On Thu, Feb 8, 2018 at 11:22 AM, Jorgenson, Janet <janet_jorgenson@fws.gov> wrote:

> Here's a list for botany/veg papers.
>
> On Thu, Feb 8, 2018 at 8:25 AM, Churchwell, Roy <roy_churchwell@fws.gov> wrote:
>
>> Hello Steve,
>>
>> Here is what I came up with. . . mostly shorebirds and coastal + a few.
>>
>> Roy
>>
>> On Wed, Feb 7, 2018 at 4:33 PM, Arthur, Stephen <stephen_arthur@fws.gov> wrote:
>>
>>> Biology folks: We have been asked to provide an bibliography of FWS-authored publications pertaining to the Alaskan Arctic, and particularly NPR-A and the 1002 Area of the Arctic Refuge. This is primarily to include publications that are not on the attached list of USGS-authored publications, but it should include publications where a FWS employee is either a primary author or coauthor.
>>>
>>> This sounds like a big task and the response is needed ASAP, so I'm hoping you all may have existing publication lists that you can provide. This would include formal publications and agency reports that are filed with ARLIS or a similar indexing service, but not purely internal reports, memos, etc.
>>>
>>> Wendy Loya will be compiling this for the Region, but if you could each send me a list of publications you know of that pertain to the Arctic Refuge, I'll forward them on to

Wendy.

Sorry for the short notice, and thanks for your help.

Steve

Stephen M. Arthur, Ph.D.
Supervisory Wildlife Biologist
Arctic National Wildlife Refuge
101 12th Ave., Room 236
Fairbanks, AK 99701
(907)455-1830

---------- Forwarded message ----------
From: **Wendy Loya** <wendy_loya@fws.gov>
Date: Wed, Feb 7, 2018 at 3:38 PM
Subject: RE: Bibliography
To: Stephen Arthur <stephen_arthur@fws.gov>, John Martin <john_w_martin@fws.gov>

Hi Steve and John,

Steve, thank you so much for taking the time to share your perspective on the bibliography. I have pulled the original email and attachment to provide as much clarity as we have. The request is following up on a bibliography prepared by the USGS for DOI on their published research efforts in 1002 and NPRA, **which is attached**. It is not the USGS Report as I previously was told (and I had not looked at the attachments to clarify). Jim Kurth passed along the request from Billy DOVE that R7 create a Bibliography if our work is not reflected in the USGS one attached.

In summary: we are looking for is a bibliography of FWS primary or co-authored publications for research in the Arctic (I would include 1002 and NPRA/broader Alaskan Arctic; as for example there may be a publications by Rick Lanctot that are not specific to 1002, but north slope wide). The audience is at DOI HQ. I recommend we restrict our bibliography to reports available through ARLIS, ScienceBase (Arctic LCC filed reports there) or the peer-reviewed literature; however if you believe there are Final Reports from significant studies that are not captured, let's discuss how we want to proceed. I do not believe we need to include "desktop" reports or interim project reports.

Please read this email carefully and let me know if the scope of work described above sounds consistent, I think we have a path forward. If not, let's discuss further.

Original Request:

From: "Dove, William" <william_dove@ios.doi.gov>
Date: January 30, 2018 at 5:08:59 PM EST
To: Jim Kurth <jim_kurth@fws.gov>
Cc: Greg Sheehan <Greg_J_Sheehan@fws.gov>
Subject: Bibliography

Jim,

I am trying to put together a bibliography on any science that we have produced on the NPR-A and the 1002 area.

We were hoping to get this information from FWS, Greg said that you might be able to help with this. I have attached the document that USGS for reference. Should you have any questions please let me know.

Best,

Billy

Billy Dove | *Special Assistant*

Office of the Assistant Secretary

Land and Minerals Management

U.S. Department of the Interior

--
Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
101 12th Ave. Room 206
Fairbanks, AK 99701
(907) 456-0450

> > https://www.fws.gov/refuge/kanuti/
>
> --
> Janet C. Jorgenson
> Botanist
> Arctic National Wildlife Refuge
> 101 12th Ave, Rm 236
> Fairbanks, Alaska 99701
>
> 907-456-0216

Citation	Reference Type	Location	Authors, Primary	Title Primary	Periodical Full	Pub Year	Links	Volume	Place Of Publication	Keywords	Abstract	Notes
Brown, Randy J. 2008. Life History and Demographic Characteristics of Arctic Cisco, Dolly Varden, and Other Fish Species in the Barter Island Region of Northern Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 101	Report	1002 Area	Brown, Randy J.	Life History and Demographic Characteristics of Arctic Cisco, Dolly Varden, and Other Fish Species in the Barter Island Region of Northern Alaska.		2008	http://arctic.fws.gov/bib/Brown_2008.pdf	U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 101	Fairbanks, Alaska		Arctic cisco Coregonus autumnalis and Dolly Varden Salvelinus malma are major fishery resources for people in coastal regions of northern Alaska and Yukon Territories. Concerted attempts to document the presence and monitor the relative abundance of these species and others began in the 1970s in response to regional development activities associated with oil exploration and extraction. Numerous sampling projects have taken place in coastal lagoon systems from the Colville River in the west to the Mackenzie River in the east. The U.S. Fish and Wildlife Service conducted an initial four	
Burkart, GA. 2007. Energy Flow in Arctic Lake Food Webs: The Roles of Glacial History, Fish Predators and Benthic-Pelagic Linkages. PhD Dissertation, Department of Watershed Sciences, Utah State University, Logan, UT. 144 pages.	Dissertation	North Slope	Burkart, GA.	Energy Flow in Arctic Lake Food Webs: The Roles of Glacial History, Fish Predators and Benthic-Pelagic Linkages. PhD Dissertation, Department of Watershed Sciences, Utah State University, Logan, UT. 144 pages.								
Burkart, GA, C Luecke, SD Miller, T Simmons. 2009. Monitoring protocol for large lake communities and ecosystems in the Arctic Network. Report for the National Park Service, Fairbanks, AK. 422 pages.	Report	North Slope	Burkart, GA, C Luecke, SD Miller, T Simmons.	Monitoring protocol for large lake communities and ecosystems in the Arctic Network. Report for the National Park Service, Fairbanks, AK. 422 pages.		2009						

Cherry J, GA Burkart. 2011. Feasibility of using Remote Sensing for Water Resource and Fish Habitat Management on Alaska's North Slope. Report to the National Petroleum Reserve-Alaska, Bureau of Land Management.	Report	North Slope - NPR-A	Cherry J, GA Burkart	Feasibility of using Remote Sensing for Water Resource and Fish Habitat Management on Alaska's North Slope. Report to the National Petroleum Reserve- Alaska, Bureau of Land Management.		2011							
Corning, R. V. 1990. Life history findings for Arctic Grayling (Thymallus arcticus)Of the Tamayariak river drainage; Alaska. U.S. Fish and Wildlife Service, Region 7 Water Resources Branch, Fisheries Management Services unpublished report	Report	1002 Area	Corning, R. V.	Life history findings for Arctic Grayling (Thymallus arcticus)Of the Tamayariak river drainage; Alaska.		1990	http://arctic.fws.gov/bib/corning_1990a.pdf	U.S. Fish and Wildlife Service, Region 7 Water Resources Branch, Fisheries Management Services unpublished report		Alaska;Arctic Grayling;Thymallus Arcticus;Arctic Char;Salvelinus alplnus;Ninespine Stickleback;Pungitius pungitius;Life History;Habitat;Length Frequency;Length-			
Corning, R. V. 1990. Fish inventories of the Jago and Katakturuk river drainages, 1002 Area of the Arctic National Wildlife Refuge. U.S. Fish and Wildlife Service Region 7, Water Resources Branch, Fisheries Management Services unpublished report	Report	1002 Area	Corning, R. V.	Fish inventories of the Jago and Katakturuk river drainages, 1002 Area of the Arctic National Wildlife Refuge.		1990		U.S. Fish and Wildlife Service Region 7, Water Resources Branch, Fisheries Management Services unpublished report		Alaska;Arctic Grayling;Thymallus Arcticus;Arctic Char;Salvelinus alplnus;Ninespine Stickleback;Pungitius pungitius;Life History;Habitat;Length Frequency;Length-Weight	Comprehensive stream inventories of the Katakturuk and Jago River drainageswere conducted in 1989 using, electrofishing gear. Purposes of the inventories were to test for the presence of fish to document the distribution of fish populations, and to document age structure of fish populations. All major drainages, and most minor drainages, were inventoried twice. A total of 93 immature anadromous Arctic char (Salvelinus alpines) and 2 ninespine stickleback. (Pungitius pungitius) were captured or observed in the Katakturuk River drainage. Twelve immature anadromous		

Elliott, George V. 1990. Quantification and distribution of winter water within lakes of the 1002 area, Arctic National Wildlife Refuge, 1989. U. S. Fish and Wildlife Service, Water Resources Branch, Alaska Fisheries Technical Report 7	Report	1002 Area	Elliott, George V.	Quantification and distribution of winter water within lakes of the 1002 area, Arctic National Wildlife Refuge, 1989.		1990	http://arctic.fws.gov/bib/elliott_1990.pdf	U. S. Fish and Wildlife Service, Water Resources Branch, Alaska Fisheries Technical Report 7	Anchorage, Alaska	inventory;lake;basin;Arctic;Refuge;1002;database;water;oil;gas;depth;volume;ice	An inventory of lake basins was conducted in the 1002 area of the Arctic National Wildlife Refuge as part of an effort to develop a hydrologic data base, map sources of winter water and determine water availability for oil and gas activities. From June 24 to August 17, 1989, depth profiles of 52 lakes within the 1002 area were measured using a recording fathometer. The depth profile data were used to construct contour maps, calculate lake volumes and estimate winter water volumes beneath ice cover. Total estimated volume of the study lake was 42,215 acre-ft when free of ice and 3,021 acre-ft	12 pp. + appendices

Elliott, George V. 1989. Winter water availability on the 1002 area of the Arctic National Wildlife Refuge. U.S. Fish and Wildlife Service, Water Resources Branch Alaska Fisheries Technical Report 3	Report	1002 Area	Elliott, George V.	Winter water availability on the 1002 area of the Arctic National Wildlife Refuge.		1989	http://arctic.fws.gov/bib/elliott_1989.pdf	U.S. Fish and Wildlife Service, Water Resources Branch Alaska Fisheries Technical Report 3	Anchorage, Alaska	inventory;lake;basin;Arctic;Refuge;1002;database;water;oil;gas;depth;volume;ice	During March 25-30, 1988, an inventory of winter water availability was conducted within the 1002 area of the Arctic National Wildlife Refuge. A helicopter mounted radar system was used to identify the presence of sub-ice water. Water was found to be widely distributed throughout much of the 1002 area in several settings: springs and associated aufeis formations; lakes; a deep river pool; and localized pools beneath ice pressure ridges occupying braided river floodplains. Pressure ridge pools accounted for the most frequent and widespread occurrence of water identified during this	30pp

Elliott, GV, SM Lyons. 1990. Quantification and distribution of winter water within river systems of the 1002 area, Arctic National Wildlife Refuge. U.S. Fish and Wildlife Service unpublished report	Report	1002 Area	Elliott, GV, SM Lyons.	Quantification and distribution of winter water within river systems of the 1002 area, Arctic National Wildlife Refuge.		1990	http://arctic.fws.gov/bib/elliott_and_lyons_1990.pdf	U.S. Fish and Wildlife Service unpublished report	Anchorage, Alaska	United States;Alaska;Arctic National Wildlife Refuge;frost mounds;naleds;unfrozen water content;water storage;river ice	An inventory of the distribution and quantity of winter water in rivers was conducted within the 1002 area of the Arctic National Wildlife Refuge as part of an effort to develop a hydrologic data base, map sources of winter water, and determine water availability for oil and gas activities. During April 10 through 19, 1989, locations of ice hummocks on all major river drainages in the area were identified using a LORAN navigation instrument. A subsample of nine hummocks was drilled to delineate water pool volumes. A positive linear relationship between hummock size and pool volume was	

Emers, M, M Raynolds. 1999. Salt Marshes of the Arctic National Wildlife Refuge. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge Narrative Report	Report	1002 Area	Emers, M, M Raynolds.	Salt Marshes of the Arctic National Wildlife Refuge.		1999	http://arctic.fws.gov/bib/Emers_and_Raynolds_1999.pdf	U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge Narrative Report			Introduction: The purpose of this study was to map all salt marshes along the coastline of the Arctic National Wildlife Refuge, from the Canning River to the Canadian border. These salt marshes are found on the northern coast of the Arctic NWR, along the shores of the Beaufort Sea. The diurnal fluctuations of tides and wave action or seasonal fluctuations of storm surges creates a band of halophytic vegetation along coastlines and estuaries. This type of vegetation is referred to as salt marsh. Because of their geomorphic position, salt marshes receive influxes of nutrients	6 pp

Fruge, DJ, DE Palmer. 1994. Fishery management plan Arctic National Wildlife Refuge FY 1994-1998. U. S. Fish and Wildlife Service, Fisheries Resource Office	Report	1002 Area	Fruge, DJ, DE Palmer.	Fishery management plan Arctic National Wildlife Refuge FY 1994-1998.		1994		U. S. Fish and Wildlife Service, Fisheries Resource Office	Fairbanks, Alaska	North Slope;Arctic National Wildlife Refuge;ANWR;Canning river;Porcupine river;anadromous fish;marine fish;fish;Arctic char;Arctic grayling;lake trout;salmon;white fish;northern pike;burbot;Arctic cod;Kaktovik;Arctic village;oil and gas exploration and development;Kongakut river;subsistence	EXECUTIVE SUMMARY: The Arctic National Wildlife Refuge, comprised of approximately 19 million acres in northeastern Alaska, was originally established as the Arctic National Wildlife Range by an executive order in 1960. The Alaska National Interest Lands Conservation Act of 1980 (Alaska Lands Act) redesignated the range as a national wildlife refuge and expanded the area to its current configuration. A comprehensive conservation plan for the refuge was completed in September 1988. According to that plan the non-wilderness portions of the refuge will be managed	111 pp.

Fruge, DJ, DW Wiswar, LJ Dugan, DE Palmer. 1989. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, Summer 1988. Alaska Fisheries Progress Report	Report	1002 Area	Fruge, DJ, DW Wiswar,LJ Dugan, DE Palmer.	Fish population characteristics of Arctic National Wildlife Refuge coastal waters, Summer 1988.		1989		Alaska Fisheries Progress Report	Fairbanks, Alaska	fish;distribution;abundance;age;condition;movement;Beaufort;Arctic;Alaska;fyke;nets;gill;Camden;Kaktovik;Jago;Pokok;temperature;water;salinity;cod;cisco;fourhorn;sculpin;char;ninespine;stickleback;flounder;least;capelin;mark;recapture;length;weight	Fishes inhabiting Beaufort Sea coastal waters within and near the Arctic National Wildlife Refuge, Alaska were sampled at eight fyke net and six gill net stations during the summer 1988 open-water season (approximately mid-July through mid-September). Specific study areas included Camden Bay, the Kaktovik and Jago lagoons area and Pokok Bay. Concurrent physical habitat measurements in each study area included water temperature and salinity, current direction and velocity and wind direction and velocity. Eighteen fish species were collected	

Furniss,RA, KT Alt. 1976. Inventory and cataloging of north slope waters. Alaska Department of Fish and Game, Sport Fish Division unpublished report Vol. 17; G-I-O	Report	1002 Area	Furniss,RA, KT Alt.	Inventory and cataloging of north slope waters.		1976		Alaska Department of Fish and Game, Sport Fish Division unpublished report Vol. 17; G-I-O	Juneau, Alaska	char;Sagavanirktok;Echooka;Ivishak;round whitefish;grayling	A study was conducted on the Sagavanirktok River and its tributaries to identify fish overwintering habitat and, if possible, capture overwintering fish. A gill net set under the ice of the Sagavanirktok River near Franklin Bluffs resulted in capture of adult grayling, Thymallus arcticus (Pallas), and round whitefish, Prosopium cylindraceum (Pallas), but failed to reveal the presence of Arctic char Salvelinus alpinus (Linnaeus). Three headwater spring areas of Sagavanirktok tributaries were sampled with minnow traps, capturing 167 juvenile char. Thirty-two adult Arctic char were	pp. 129:

Hale, DA. 1991.A description of the physical characteristics of nearshore and lagoonal waters in the eastern Beaufort Sea, 1989. Report prepared for Fishery Assistance Office, U.S. Fish and Wildlife Service	Report	1002 Area	Hale, DA.	A description of the physical characteristics of nearshore and lagoonal waters in the eastern Beaufort Sea, 1989.		1991		Report prepared for Fishery Assistance Office, U.S. Fish and Wildlife Service	Anchorage, Alaska		Summary "The 1989 oceanographic measurement program utilized a series of nearshore current meter moorings, supplemented with meteorological measurements and vertical CTD surveys, to determine the temporal and spatial hydrographic characteristics of three regions representative of different fish habitats found in the eastern Beaufort Sea. Two current meter moorings, with a total of three current meters, were deployed in the nearshore region of Camden Bay. Complete records of current speed and direction, temperature, and conductivity from	82 pages, plus 100 pages of appendices
Luecke, C, AE Giblin, ND Bettez, GA Burkart, BC Crump, MA Evans, GG Gettel, S MacIntyre, WJ O'Brien, P.A. Rublee, G.W. Kling. 2014.2014. The response of lakes near the Arctic LTER to environmental change. Pages 238-286 in Hobbie, J, and GW Kling, Alaska's Changing Arctic, Ecological Consequences for Tundra, Streams, and Lakes. Oxford University Press. 2014. 331	Book chapter	North Slope	Luecke, C, AE Giblin, ND Bettez, GA Burkart, BC Crump, MA Evans, GG Gettel, S MacIntyre, WJ O'Brien, P.A. Rublee, G.W. Kling.	2014. The response of lakes near the Arctic LTER to environmental change. Pages 238-286 in Hobbie, J, and GW Kling, Alaska's Changing Arctic, Ecological Consequences for Tundra, Streams, and Lakes. Oxford University Press. 2014. 331 pages.		2014						

Lyons, Steven M. 1990. Water resource inventory and assessment, Arctic National Wildlife Refuge. U. S. Fish and Wildlife Service Alaska Fisheries Technical Report	Report	1002 Area	Lyons, Steven M.	Water resource inventory and assessment, Arctic National Wildlife Refuge.		1990		U. S. Fish and Wildlife Service Alaska Fisheries Technical Report	Anchorage, Alaska	Arctic;Alaska;water;stream;discharge;resource;inventory;assessment		Vol. 8; 1989 stream discharge gauging data;9 pp. + ca. 75 pp. of tabular data
Lyons, Steven M. 1989. Water resource inventory and assessment, Arctic National Wildlife Refuge, 1988 stream discharge gaging data. U.S. Fish and Wildlife Service, Alaska Fisheries Progress Report	Report	1002 Area	Lyons, Steven M.	Water resource inventory and assessment, Arctic National Wildlife Refuge, 1988 stream discharge gaging data.		1989		U.S. Fish and Wildlife Service, Alaska Fisheries Progress Report	Anchorage, Alaska			
Lyons, SM, JM Trawicki. 1994. Water resource inventory and assessment, coastal plain, Arctic National Wildlife Refuge 1987-1992 final report. U. S. Fish and Wildlife Service, Water Resource Branch WRB 94-3	Report	1002 Area	Lyons, SM, JM Trawicki.	Water resource inventory and assessment, coastal plain, Arctic National Wildlife Refuge 1987-1992 final report.		1994	http://arctic.fws.gov/bib/lyons_and_trawicki_1994.pdf	U. S. Fish and Wildlife Service, Water Resource Branch WRB 94-3	Anchorage, Alaska	water;resource;inventory;Arctic;Alaska;stream;discharge;gaging;data;assessement;winter;Akutoktak River;Itkilyariak Creek (West Fork);Niguanak River;Sadlerochit		31 pp. + ca. 45 pp. appendix; watersheds studied:
Lyons, SM, JM Trawicki. 1993. Water resource inventory and assessment, Arctic National Wildlife Refuge, 1992 stream discharge gaging data. U.S. Fish and Wildlife Service Water Resources Progress Report 93-1	Report	1002 Area	Lyons, SM, JM Trawicki.	Water resource inventory and assessment, Arctic National Wildlife Refuge, 1992 stream discharge gaging data.		1993		U.S. Fish and Wildlife Service Water Resources Progress Report 93-1	Anchorage, Alaska	Akuktoktak river;Ikilyariak Creek;Niguanak River;Sadlerochit river;Sikrelurak river;Tamayariak river;Sadlerochit spring creek		Extensive appendices of Surface discharge records A - 41pp and Water Surface temperature records B-45pp, 11 pp. + Appendices
Lyons, SM, JM Trawicki. 1992. Water resource inventory and assessment, Arctic National Wildlife Refuge, 1991 stream discharge gaging data. U. S. Fish and Wildlife Service Alaska Fisheries Progress Report 92-2	Report	1002 Area	Lyons, SM, JM Trawicki.	Water resource inventory and assessment, Arctic National Wildlife Refuge, 1991 stream discharge gaging data.		1992		U. S. Fish and Wildlife Service Alaska Fisheries Progress Report 92-2				12 pp. + ca. 75 pp. tabular data

Lyons, SM, JM Trawicki. 1991. Water resource inventory and assessment Arctic National Wildlife Refuge 1990 stream discharge gaging data. U. S. Fish and Wildlife Service Alaska Fisheries Progress	Report	1002 Area	Lyons, SM, JM Trawicki.	Water resource inventory and assessment Arctic National Wildlife Refuge 1990 stream discharge gaging data.		1991	http://alaska.fws.gov/fisheries/fish/Progress_Reports/p_07.pdf	U. S. Fish and Wildlife Service Alaska Fisheries Progress Report	Anchorage, Alaska	water;resource;inventory;Arctic;Alaska;stream;discharge;gaging;data;assessement		12 pp. + ca. 75 pp. appendices
Lyons, SM, GV Elliott. 1987. FY-1987 status report federal reserve water rights, Arctic National Wildlife Refuge. unpublished report, Branch of Water Resources Operations, U.S. Fish and Wildlife Service	Report	1002 Area	Lyons, SM, GV Elliott.	FY-1987 status report federal reserve water rights, Arctic National Wildlife Refuge.		1987		unpublished report, Branch of Water Resources Operations, U.S. Fish and Wildlife Service	Anchorage, Alaska		Summary: Documents the findings of two reconnaissance field trips in the 1002 area in 1987.	
Martin,PD., CS Moitoret. 1981. Bird populations and habitat use, Canning River Delta, Alaska. unpublished report U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge	Report	1002 Area	Martin,PD., CS Moitoret.	Bird populations and habitat use, Canning River Delta, Alaska.		1981	http://arctic.fws.gov/bib/Martin_and_Moritoret_1981.pdf	unpublished report U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge	Fairbanks, Alaska	North Slope;Arctic National Wildlife Refuge;ANWR;birds;shorebirds;sea birds;waterfowl;passerines;sea duck;Canning River;habitat;tundra;vegetation classification;Beauf		

Osborne, BM, J Melegari. 2008. Site Selection and Feasibility of Enumerating Dolly Varden using Dual Frequency Identification Sonar in the Hulahula River, Arctic National Wildlife Refuge, Alaska, 2006. Fisheries Information Services, Annual Report FIS 04-103	Preliminary report with no final report	1002 Area	Osborne, BM, J Melegari.	Site Selection and Feasibility of Enumerating Dolly Varden using Dual Frequency Identification Sonar in the Hulahula River, Arctic National Wildlife Refuge, Alaska, 2006.		2008	http://alaska.fws.gov/asm/pdf/fisheries/reports/04-103final.pdf	Fisheries Information Services, Annual Report FIS 04-103	Fairbanks, Alaska		A study using a fixed-location, Dual Frequency Identification Sonar (DIDSON) was initiated in 2004 to assess the population status of Dolly Varden Salvelinus malma in the Hulahula River, Alaska. An abundance estimate from the DIDSON data was generated to describe the variability in run size and timing of Dolly Varden. During 2006 data collection began August 1 and continued through September 20. A total of 1,157 hours of data was collected, providing an estimate of 7,471 Dolly Varden migrating upriver. Species identification was accomplished with hook and line sampling, beach	

Palmer, DE, LJ Dugan. 1990. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, Summer 1989. U. S. Fish and Wildlife Service Alaska Fisheries Progress Report	Report	1002 Area	Palmer, DE, LJ Dugan.	Fish population characteristics of Arctic National Wildlife Refuge coastal waters, Summer 1989.		1990		U. S. Fish and Wildlife Service Alaska Fisheries Progress Report	Fairbanks, Alaska	fish;distribution;abundance;age;condition;movement;Beaufort;Arctic;Alaska;fyke;nets;gill;Camden;Kaktovik;Jago;habitat;temperature;salinity;net;cod;cisco;fourhorn;sculpin;char;ninespine;stickleback;flounder;capelin;length;weight;sex	Fishes inhabiting Beaufort Sea coastal waters within and near the Arctic National Wildlife Refuge, Alaska were sampled at eight fyke net and three gill net stations during the summer 1989 open-water season (approximately mid-July through mid-September). Specific study areas included Camden Bay, Kaktovik, Jago and Beaufort lagoons. Concurrent physical habitat measurements in each study area included water temperature and salinity. Current direction and velocity and wind direction and velocity were monitored at Camden Bay and Beaufort Lagoon.	82 pp
Pollard,DD, DS Segar. 1994. A description of the physical characteristics of nearshore and lagoonal waters in the eastern Beaufort Sea, 1990. Final Report for U.S. Department of Commerce, NOAA/NOS, Ocean Resources Conservation and Assessment and the U. S. Fish and Wildlife Service, Region 7, Fairbanks Fishery Resource Office	Report	1002 Area	Pollard,DD, DS Segar.	A description of the physical characteristics of nearshore and lagoonal waters in the eastern Beaufort Sea, 1990.		1994		Final Report for U.S. Department of Commerce, NOAA/NOS, Ocean Resources Conservation and Assessment and the U. S. Fish and Wildlife Service, Region 7, Fairbanks Fishery Resource Office	Anchorage, Alaska.			

Spindler, MA. 1978. Bird populations and habitat use on the Okpilak River Delta area, Arctic National Wildlife Range, 1978. U.S. Fish and Wildlife Service unpublished report	Report	1002 Area	Spindler, MA.	Bird populations and habitat use on the Okpilak River Delta area, Arctic National Wildlife Range, 1978.		1978	http://arctic.fws.gov/bib/Spindler_1978c.pdf	U.S. Fish and Wildlife Service unpublished report	Fairbanks, Alaska		Bird census plots totalling 1.75 km2 in area on the Okpilak River delta, Arctic National Wildlife Range, Alaska, were sampled to determine nesting bird density and total breeding and non-breeding population during the summer of 1978. A total of 57 bird species were observed on the study area, while 23 species were recorded as breeding. The most abundant species were (in descending order): Lapland Longspur, Pectoral Sandpiper, Red Phalarope, Northern Phalarope, and Semipalmated Sandpiper. Bird populations varied about two-fold between	83 pp	

Spindler, MA, RH, Meehan, AW Brackney. 1987. A preliminary study of epibenthic invertebrates and water quality in coastal lagoons of the Arctic National Wildlife Refuge.	Book, Section	1002 Area	Spindler, MA, RH, Meehan, AW Brackney.	A preliminary study of epibenthic invertebrates and water quality in coastal lagoons of the Arctic National Wildlife Refuge.		1987	http://arctic.fws.gov/bib/Spindler_et_al_1987.pdf		Anchorage, Alaska		A preliminary study of factors which affect the distribution and abundance of epibenthic invertebrates in. coastal lagoons of the Arctic National Wildlife Refuge was conducted during 7uly - early August 1981. Invertebrate abundance was hypothesized as a factor affecting waterfowl abundance and distribution. Samples from 5 net grabs at stations in each of 4 habitat types (mainland shoreline, mid-lagoon, barrier island, pass) in 8 lagoons showed no significant differences in numbers of mysids, amphipods, large amphipods (Onismus sp. + Gammarus sp.) or total	ANWR Progress Report FY86-24; 1281 pp.	
Trawicki, JM. 2000. Final Report Water Resources Inventory and Assessment Yukon Flats National Wildlife Refuge (Water Years 1993-1998). Water Resources Branch, U.S. Fish and Wildlife Service, WRB 00-04	Report	1002 Area	Trawicki, JM.	Final Report Water Resources Inventory and Assessment Yukon Flats National Wildlife Refuge (Water Years 1993-1998).		2000	http://alaska.fws.gov/water/pdf/reports/Report%20WRB%2000-04.pdf	Water Resources Branch, U.S. Fish and Wildlife Service, WRB 00-04	Anchorage, Alaska				
Trawicki, JM. 1992. Overview of the water resources of the coastal plain of the Arctic National Wildlife Refuge.	Conference Proceedings	1002 Area	Trawicki, JM.	Overview of the water resources of the coastal plain of the Arctic National Wildlife Refuge.		1992			Fairbanks	United States;Alaska;Arctic National Wildlife Refuge;permafrost beneath lakes;permafrost beneath rivers;ice			

Trawicki, JM, SM Lyons, GV Elliott. 1991. Distribution and quantification of water within the lakes of the 1002 area, Arctic National Wildlife Refuge. Alaska Fisheries Technical Report Vol. 10	Report	1002 Area	Trawicki, JM, SM Lyons, GV Elliott.	Distribution and quantification of water within the lakes of the 1002 area, Arctic National Wildlife Refuge.		1991	http://arctic.fws.gov/bib/trawicki_et_al_1991.pdf	Alaska Fisheries Technical Report Vol. 10	Anchorage, Alaska	inventory;water;Alaska;Arctic;hydrologic;database;availability;depth;1001;volume;ice;Canning;Katakturuk;Sadlerochit;ninespine;stickleback	An inventory of lake basins in the 1002 area of the ANWR was conducted as part of an effort to develop a hydrologic data base, map sources of water and quantify water availability. Using a recording fathometer, depth profile measurements were taken on 119 lakes within the 1002 area during the summer months of 1988, 1989 and 1990. Fathometer output was used to construct lake contour maps, calculate volumes, and estimate winter water beneath ice cover. Total estimated volume of the study lakes ranged from 55,382 acre-ft when free of ice to 3,366 acre-ft	12 pp. + appendices
Underwood, TJ. 1992. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1991.. U. S. Fish and Wildlife Service Fishery Resource Office, Alaska Fisheries Progress Report 94-1	Report	1002 Area	Underwood, TJ.	Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1991..		1992		U. S. Fish and Wildlife Service Fishery Resource Office, Alaska Fisheries Progress Report 94-1	Fairbanks, Alaska			129 pp

Underwood, TJ, JA Gordon, MJ Millard, LA Thorpe, BM Osborne. 1995. Characteristics of Selected Fish Populations of Arctic National Wildlife Refuge Coastal Waters, Final Report, 1988-1991. U.S. Fish and Wildlife Service, Fairbanks Fishery Resource Office, Alaska Fisheries Technical Report No. 28	Report	1002 Area	Underwood, TJ, JA Gordon, MJ Millard, LA Thorpe, BM Osborne.	Characteristics of Selected Fish Populations of Arctic National Wildlife Refuge Coastal Waters, Final Report, 1988-1991.		1995	http://arctic.fws.gov/bib/Underwood_et_al_1995.pdf	U.S. Fish and Wildlife Service, Fairbanks Fishery Resource Office, Alaska Fisheries Technical Report No. 28	Fairbanks, Alaska.	fish;distribution;relative abundance;age;fish condition;movements;Arctic National Wildlife Refuge;Beaufort Sea;Dolly Varden char;arctic cisco;marine;arctic flounder;fourhorn sculpin;arctic cod	We used fyke nets and hydrographic equipment from 1988 to 1991 to study fish in nearshore waters of the Arctic National Wildlife Refuge, Alaska. Crews collected data for analyses of relative abundance and distribution, size structure, condition, and age and growth for five target species: Dolly Varden char Salvelinus malma, Arctic cisco Coregonus autumnalis, Arctic flounder Liopsetta glacialis, fourhorn sculpin Microcephalus quadricornis, and Arctic cod Boreogadus saida. Coastal movements of the target species except for Arctic cod were examined from recaptured fish marked	590 pp; Series Issue ID:

Underwood, TJ, JA Gordon, BM Osborne. 1992. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1990. U. S. Fish and Wildlife Service Fishery Resource Office, Alaska Fisheries Progress Report 92-3	Report	1002 Area	Underwood, TJ, JA Gordon, BM Osborne.	Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1990.		1992		U. S. Fish and Wildlife Service Fishery Resource Office, Alaska Fisheries Progress Report 92-3	Fairbanks, Alaska	fish;distribution;abundance;age;condition;movement;Beaufort;Arctic;Alaska;char;cisco;gill;nets;fyke;growth;anadromous;Camden;Kaktovik;Jago;water;temperature;cod;fourhorn;sculpin;flounder;least;capelin;ninespine;stickleback;length;weight;dye;mark;recapture;tagging;Floy;Prudhoe;Colville;Canada	In 1990 fishes in the coastal waters of the Arctic NWR, Alaska were sampled with gill nets and two types of fyke nets from mid-July to mid-September to determine relative abundances, distribution, growth and movement patterns of anadromous and marine fish species. Standard fyke nets were used in areas protected by barrier islands whereas smaller more mobile nets were fished on the unprotected coast. Specific sampling areas included Camden Bay, Kaktovik and Jago lagoons, and Beaufort Lagoon. Concurrent physical habitat measurements were collected including	115 pp:

Underwood, TJ, JA Gordon,LA Thorpe, BM Osborne. 1994. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1991.. U. S. Fish and Wildlife Service Fishery Resource Office Alaska Fisheries Progress Report 94.1	Report	1002 Area	Underwood, TJ, JA Gordon,LA Thorpe, BM Osborne.	Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1991..		1994		U. S. Fish and Wildlife Service Fishery Resource Office Alaska Fisheries Progress Report 94.1	Fairbanks, Alaska	fish;distribution;abundance;age;condition;movement;Beaufort;Arctic;Alaska;char;cisco;gill;nets;fyke;growth;anadromous;Camden;Kaktovik;Jago;water;temperature;cod;fourhorn;sculpin;flounder;least;capelin;ninespine;stickleback;length;weight;dye;mark;recapture;tagging;Floy;Prudhoe;Colville;Canada	Fyke nets were used to sample marine and anadromous fishes in protected coastal lagoons and coves adjacent to the Arctic National Wildlife Refuge (Arctic Refuge) from July 12 to September 12, 1991. Crews collected data for analyses of relative abundance and distribution on all species that were caught. In addition, condition, growth, and maturity data were analyzed for five target species: Arctic char Salvelinus alpinus, Arctic cisco Coregonus autumnalis, Arctic flounder Liopsetta glacialis, fourhorn sculpin Microcephalus quadricornis, and Arctic cod Boreogadus saida.	129 pp

Underwood, TJ, MJ Millard, LA Thorpe. 1996. Relative abundance, length frequency, age, and maturity of Dolly Varden in nearshore waters of the Arctic National Wildlife Refuge, Alaska. 125	Journal Article	1002 Area	Underwood, TJ, MJ Millard, LA Thorpe.	Relative abundance, length frequency, age, and maturity of Dolly Varden in nearshore waters of the Arctic National Wildlife Refuge, Alaska.	Transactions of the American Fisheries Society	1996	http://www.tandfonline.com/doi/pdf/10.1577/1548-8659%281996%29125%3C0719%3ARALFAA%3E2.3.CO%3B2	125			Uncertainty about the environmental effects of oil development prompted a study of Dolly Varden Salvelinus malma in the nearshore waters of the Arctic National Wildlife Refuge, Alaska. Abundance of fish less than 400 mm fork length (FL), as indexed by fyke net catch per unit effort (CPUE), was significantly different among years, with the highest daily catch rates occurring in 1991, a year of heavy pack ice and relatively cold water temperatures. The CPUE for fish 400 mm or greater did not differ significantly among years. Within each sampling year, both large and small fish	

Underwood, TJ, DE Palmer, LA Thorpe, BM Osborne. 1997. Weight-length relationships and condition of dolly varden in coastal waters of the Arctic National Wildlife Refuge, Alaska. 19	Journal Article	1002 Area	Underwood, TJ, DE Palmer, LA Thorpe, BM Osborne.	Weight-length relationships and condition of dolly varden in coastal waters of the Arctic National Wildlife Refuge, Alaska.	American Fisheries Society Symposium	1997		19		coastal plain;Barter Island;Beaufort Lagoon;Simpson Cove;body condition	Few baseline parameters have been established for arctic fish populations, despite the need for comparison of baseline data to collections from developed areas. Using least-squares regression, we established body condition baselines for Dolly Varden Salvelinus malma inhabiting the nearshore coastal waters of the Arctic National Wildlife Refuge, Alaska. Biologists collected length and weight data during two time periods in three areas (Simpson Cove, Barter Island, and Beaufort Lagoon) over 4 years (1988-1991). Using covariance analyses, we detected differences in body condition within	

West, RL, DJ Fruge. 1989. A review of coastal plain fish surveys and the results of 1986 fish surveys of selected coastal lakes and streams, Arctic National Wildlife Refuge, Alaska. U.S. Fish & Wildlife Service Fishery Resource Office, Alaska Fisheries Technical Report Number 4	Report	1002 Area	West, RL, DJ Fruge.	A review of coastal plain fish surveys and the results of 1986 fish surveys of selected coastal lakes and streams, Arctic National Wildlife Refuge, Alaska.		1989	http://arctic.fws.gov/bib/west_and_fruge_1989.pdf	U.S. Fish & Wildlife Service Fishery Resource Office, Alaska Fisheries Technical Report Number 4	Fairbanks, Alaska	Alaska;fish;surveys;Arctic Refuge	A review of fish surveys of Beaufort Sea drainages, north slope lakes and nearshore waters of the Arctic National Wildlife Refuge is presented. Also, fish surveys of nine lakes and six streams within the coastal plain of the refuge were conducted during early July, 1986. Sample sites were selected based upon their proximity to potential oil and gal development, suitability as water sources, and potential to support fish populations. Significant fish populations were not discovered at any of the sites, although ninespine stickleback were found in three lakes and three streams, and a single Arctic	17 pp

West, RL, MD Smith, WE Barber, JB Reynolds, H Hop. 1992. Autumn Migration and Overwintering of Arctic Grayling in Coastal Streams of the Arctic National Wildlife Refuge, Alaska. 121	Journal Article	1002 Area	West, RL, MD Smith, WE Barber, JB Reynolds, H Hop.	Autumn Migration and Overwintering of Arctic Grayling in Coastal Streams of the Arctic National Wildlife Refuge, Alaska.	Transactions of the American Fisheries Society	1992	http://docushare.sf.adfg.state.ak.us/docushare/dsweb/Get/Document-35806/WestEtAl1992.pdf	121			During 1984 and 1985, 67 adult Arctic grayling Thymallus arcticus with surgically implanted radio transmitters were released at their summer feeding areas in three river systems of the Arctic National Wildlife Refuge, Alaska. We tracked the fish from aircraft to determine patterns of autumn migration to overwintering locations. During August or September in each area, fish left the small tundra streams where they were tagged and migrated into larger streams. Migration rates peaked at 5-6 km/d about 1 September and averaged 1 km/d. Fish in two river systems moved into adjacent	

Willms, MA. 1992. Arctic National Wildlife Refuge migratory bird use of potential port sites. U.S. Fish Wildlife Service Final Report	Report	1002 Area	Willms, MA.	Arctic National Wildlife Refuge migratory bird use of potential port sites.		1992	http://arctic.fws.gov/bib/Willms_1992.pdf	U.S. Fish Wildlife Service Final Report	Anchorage, Alaska.		SUMMARY"Avian densities varied widely within and among years (P 0.06). However, red-necked phalaropes (Phalaropus lobatus) (P 0.06). However, red-necked phalaropes (Phalaropus lobatus) (P 0.06). However, red-necked phalaropes (Phalaropus lobatus) (P 0.06). However, red-necked phalaropes (Phalaropus lobatus) (P 0.06). However, red-necked phalaropes (Phalaropus lobatus) (P 0.06). However, red-necked phalaropes (Phalaropus lobatus) (P 400 m from shore, revealed that a second oldsquaw concentration area was located in Camden Bay extending for about 4 miles west-	126 pp

Wilson, WJ, EH Buck,H Eugene H, GF Player,LD Dreyer. 1977. Winter water availability and use conflicts as related to fish and wildlife in Arctic Alaska â€“ a synthesis of information. Arctic Environmental Information and Data Center, University of Alaska FWS/OBS-77/06.	Report	1002 Area	Wilson, WJ, EH Buck,H Eugene H, GF Player,LD Dreyer.	Winter water availability and use conflicts as related to fish and wildlife in Arctic Alaska â€“ a synthesis of information.		1977		Arctic Environmental Information and Data Center, University of Alaska FWS/OBS-77/06.	Anchorage	cold weather tests;arctic regions;water resources;wildlife; wate hydrology;conflicts ;availability;seasonal variations;alaska;arctic environment	Summary: Dated but informative AEIDC report of winter water availability in Arctic Alaska. Four of the seven chapter address water availability in winter, importance of unfrozen water during winter to arctic fish and wildlife, water use, and conflicts between water use and fish or wildlife habitat needs during winter. Topics include use patterns of arctic fish, quantification of water use by oil companies in vicinity of Prudhoe Bay, fish overwintering, water withdrawal as a threat to overwintering fish, etc. Each chapter ends with an extensive list of references cited. Some photos are included,	221 pp

Wiswar, DW, RL. West,WM Winkleman. 1995. Fisheries investigation in Oruktalik Lagoon, Arctic National Wildlife Refuge, Alaska, 1986. U.S. Fish & Wildlife Service Alaska Fisheries Technical Report 30	Report	1002 Area	Wiswar, DW, RL. West,WM Winkleman.	Fisheries investigation in Oruktalik Lagoon, Arctic National Wildlife Refuge, Alaska, 1986.		1995	http://arctic.fws.gov/bib/Wiswar_et_al_1995.pdf	U.S. Fish & Wildlife Service Alaska Fisheries Technical Report 30	Fairbanks, Alaska	Alaska;Arctic;Oruktalik;abundance;distribution;movement;hydrology;fyke;nets;habitat;Beaufort;cisco;fourhorn;sculpin;cod;Dolly;Varden;length;recapture;mark;oil;development	Fishes inhabiting Oruktalik Lagoon, Alaska were sampled between July 5 and September 14, 1986 to determine 1) relative abundance, distribution and movements, 2) biological characteristics, and 3) relationship between catch rate and hydrologic variables. Fish were captured at three stations by fyke nets with leads extending perpendicular from shore. Sampling at the stations varied between 31 and 58 d. Concurrent physical habitat measurements were surface water temperature and salinity. Species composition and relative abundance	38 pp

From:	Fox, Joanna
To:	Hollis Twitchell; Roger Kaye
Cc:	Jennifer Reed; Fischbach, Tracy; Steve Berendzen
Subject:	Fwd: Please review Visitor Use Technical Report...
Date:	Tuesday, February 13, 2018 11:17:41 AM
Attachments:	20180212 Arctic Refuge 1002 Visitor Use Technical Report - Short.docx

Attached please find the draft Visitor Use Resource Assessment report Jennifer and Tracy Fischbach have provided for review. Please provide any editorial comments you have to Jennifer and Tracy asap so they are able to incorporate your suggestions prior to the Friday, February 16 deadline.

Thank you!

____

Joanna L. Fox
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"Do what you can, with what you have, where you are." -- Theodore Roosevelt

Arctic Refuge 1002 Visitor Use Technical Report

Discipline/Subject Area: Visitor Use

Lead facilitators: Jennifer Reed, Arctic Refuge (907) 455-1835; and Tracy Fischbach, FWS RO Refuges (907) 786-3369

Individuals contacted: Roger Kaye, Wilderness Discipline/Subject Area Lead; Hollis Twitchell, Subsistence Use Discipline/Subject Area Lead; Steve Berendzen, Arctic Refuge Manager; Tom Bickauskus, BLM State Lead for Recreation, NLCS, NHST and W&SR

What do we need to know and why regarding subjects?

Definition of "Visitor": The term "visitor" includes any person who takes part in recreation, including, general hunting and fishing activities. Issues noted here may also affect subsistence users or local residents that are not subsistence users as defined, but who are also not considered visitors. Only visitors are considered in this report.

What and Why: Understanding current characteristics of visitor use (amount, type, timing, and distribution of visitor activities and behaviors), and visitor experiences (perceptions, feelings, and reactions that a visitor has before, during, and after a visit to an area) is essential to evaluating, and possibly minimizing, the effects of oil and gas development and infrastructure upon visitors, and ~~those~~ commercial operators that support those visitors. However, because management of the Arctic Refuge has not required visitor registration or field contacts, information about what, where, and how visitor activities occur is limited.

Effects of highest concern on visitor~~use~~ opportunities and experiences include:

- Changes in opportunities for immersion in the area's naturalness, where plant and animal species and communities or biophysical processes had previously not been altered.
- Changes in opportunities for immersion in an untrammeled Coastal Plain, that is free from modern human manipulation.
- Changes to desirability of the destination (visitor displacement resulting from new user types; and/or increased visitation by new user types).
- Changes to the timing or availability of access for recreation (both consumptive and non-consumptive uses).
- Changes to the distribution of visitors, possibly leading to crowding.
- The emergence of new behaviors, modes of travel, or activity types, possibly leading to social conflicts.
- Reduced scenic opportunities due to addition of man-made structures to the natural viewshed.
- Reduced auditory quality due to addition of man-made noise to the natural soundscape.
- Reduced quality of night sky visibility due to atmospheric light pollution.

- Reduced solitude, or abilities to be remote from the sights and sounds of other people.
- Reduced opportunities for immersion in undeveloped area void of permanent structures or modern human occupation.
- Reduced educational, scenic and historic values of the region of the Coastal Plain.
- Changes to levels of visitor satisfaction resulting from changes in overall quality of recreational opportunities.
- Changes to the quality of visitor experience could affect demand for commercial services among the majority of guide and air transporting businesses; a corresponding drop in demand for services could threaten business viability.
- Changes to business model viability for existing small-scale commercial service providers that support visitors may dramatically limit visitor access.
- Changes to the frequency of commercially-supported services may further limit managers' capacity to deliver quality visitor opportunities, since managers rely heavily upon the interests of commercial service providers to act as our eyes, ears, and workforce to deliver services.

What information is currently available to address the information needs for subjects?

Known Access Points/Routes used for Primitive/Unconfined Recreation: There are multiple areas and/or routes of known historic interest and sensitivity to visitors of the Coastal Plain:

- The historic caribou calving ground areas in May and June;
- Known caribou migration viewing areas allowing reasonable access in June and July including the following unimproved landing areas: Jago Bitty, Lower Marsh Creek, Lower Canning River; Kataktuiruk River, Aichil k River;
- Known abundant and diverse bird sighting areas include the Kaktaktuiruk River June-July;
- Routes from the Neruokpuk Lakes Complex through the Arctic Coastal Plain from March until September (includes spring ski touring);
- The route stemming from the Sadlerochit Mountains along the Kataktuiruk River to Brown Low Point
- Canning River due to its non-technical rating and floatability all summer June until September (flow); whereas the Hulahula and Kongakut are experiencing lower water levels than historically seen (Hulahula receives high winds all winter and is a "scour point" so lower water and less floatable than past);
- Coastal lagoons between Hulahula River and Kongakut River, providing paddling access to Kaktovik during open water, from June through October; and,
- Coastal Lagoons which are Marine Protected Areas in the fall from July until freeze-up (recently mid-late October) for polar bear viewing.
- Packrafting routes including Upper Marsh Fork to Kaktovik; Arctic Village to Kaktovik; Neruokpuk Lakes Complex to Kaktovik; and Turner River to Kaktovik, with resupplies at major river crossings.

Two known reports on Visitor Use:

Arctic Refuge. 2011. Arctic National Wildlife Refuge Public Use Summary

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This report, based on available indirect visitor data obtained through commercial client use reporting, and analyzed through 2009, provides a summary of historic visitor use information compiled for the area now designated within the Arctic National Wildlife Refuge boundary (up to 1997); depicts a general index of recent visitor use patterns (1998-2009) based upon available data; summarizes available harvest data for general hunting and trapping through 2009; and discusses current trends in public use with implications for future management practices.

Christensen N. and L. Christensen. 2009. Arctic National Wildlife Refuge Visitor Study: the characteristics, experiences and preferences of Refuge visitors
This report summarizes data directly collected from visitors and shows that:

- The greatest positive influence on visits came from experiencing the components of "Wilderness" (92%), "A Sense of Vastness" (92%), "Remoteness and Isolation" (89%), "A Sense of Adventure" (84%), and 'Natural Conditions" (84%).
- Refuge purposes most frequently rated as "Very Important" were "Wildlife"(97%), "Wilderness"(96%), "A bequest to future generations"(89%), "Remoteness and isolation"(89%), and 'A place where natural processes continue"(86%).
- Respondents encountered an average of two other groups on their trip, saw or heard four airplanes, and saw an average of one site with evidence of previous visitor use.

What are key information gaps?

- Baseline information on most of the concerns listed above as "Effects of highest concern on use opportunities and experiences."

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- River floating, one of the main river activities, requires adequate flow. There is limited information about the Refuge's most-visited rivers.
- Fishing is generally understood to be a secondary activity enjoyed by most visitors who float the Refuge's rivers; the extent to which fishing on the Canning and Hulahula Rivers occurs, among other Coastal Plain destinations, is unknown.
- Information about visitors who arrive on the Refuge independently and who do not use commercial services are not known.
- Client Use Reporting (CUR) by commercial air transporters does not provide consistent data about transported visitors' specific access areas and no data is requested for egress areas; therefore, there is no trip length data available from reports. CUR also does not include visitor's primary activity.
- ~~Baseline information on most of the concerns listed above as "Effects of highest concern on use opportunities and experiences."~~

What studies/surveys need to be conducted to fill those information gaps? Please include duration (start and end), staffing and cost estimates.
Ongoing efforts that could be focused or modified to meet needs:

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- Evaluate existing OMB-approved FWS visitor surveys for generalized information about Alaska Region's visitation patterns and preferences (duration: XX; lead: Natalie Sexton/Debbie Steen?; cost: XX).
- Re-evaluate 2009 visitor survey data held by Christensen, to identify any possible additional information about experience condition expectations of visitors, specific to the

Coastal Plain (duration: 3 months after contracted; lead: Neal Christensen?; cost estimate: $10K?)

- Repeat/focus Arctic Refuge Visitor Survey to obtain current data about expectations of visitors, specific to the Coastal Plain (warning: dependent upon OMB approval) (duration: lead: XX, cost estimate: XX).
- Evaluate Refuge's raw 2010-2011 Client Use Report (CUR) data, consistent with previous data, to identify additional information specific to the Coastal Plain; and of Refuge's limited 2012-2017 CUR data (reporting requirements inconsistent with previous data). (duration of effort: 6 months; lead: Reed; cost estimate: $3K for contracted database support).

New efforts that are short-term priorities, since baseline data currently does not exist:

- River flow data (duration: XX, lead: XX, cost estimate: XX).
- Viewscape baseline study (including visible pollution plume resulting from air quality affecting viewscape) to document visual resource conditions and potential future changes to existing undeveloped viewshed (duration of sampling: March-Oct, lead: XX, cost estimate: XX).
- Soundscape baseline study to document auditory resource conditions and potential future changes to existing natural sound environment (duration of sampling: March-Oct, lead: XX, cost estimate: XX).
- Night sky baseline study to document auroral, stargazing, and other astronomical resource conditions and potential future changes to existing night sky opportunities (duration of sampling: March-Oct, lead: XX, cost estimate: XX).

Management actions that could be conducted to fill some~~those~~ information gaps?

- Require air transporters to obtain primary visitor activity by unguided but transported (plane or motorboat) visitors.
- Require primary access locations to be reported as lat/long.
- Develop a voluntary registration system for non-guided, non-commercially transported visitors.

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From:	paul_leonard@fws.gov
To:	roy_churchwell@fws.gov; laura_makielski@fws.gov; christopher_latty@fws.gov; joshua_bradley@fws.gov
Subject:	Inv tation: Arctic Refuge / LCC Discussion @ Tue Feb 20, 2018 1pm - 2pm (AKST) (roy_churchwel @fws.gov)
Attachments:	invite.ics

more details » <https://www.google.com/calendar/event?
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Arctic Refuge / LCC Discussion
Paul's Office
When Tue Feb 20, 2018 1pm – 2pm Alaska Time
Video cal [redacted]
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Cc: tracy_fischbach@fws.gov; alfredo_soto@fws.gov; david_payer@nps.gov; davyd_betchkal@nps.gov; Roger_Kaye@fws.gov; kpeck@blm.gov; sfritz@blm.gov; tatwood@usgs.gov; hollis_twitchell@fws.gov; ctburns@blm.gov; DNigro@blm.gov; tbickaus@blm.gov
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Please do so by COB Thursday 15th.

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Discipline/Subject Area: Acoustic Environment

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- Davyd Betchkal (Biologist/Soundscape Specialist, NPS Natural Sounds and Night Skies Division; davyd_betchkal@nps.gov, 907-683-5754)
- Tracy Fischbach (Natural Resources Planner, National Wildlife Refuge System – Region 7; tracy_fischbach@fws.gov, 907-786-3369)
- Tracey Fritz (Anthropologist, BLM Arctic District; sfritz@blm.gov, 907-474-2309)
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- Hollis Twitchell (Assistant Manager, USFWS Arctic National Wildlife Refuge; hollis_twitchell@fws.gov, 907-456-0512)

What do we need to know and why regarding subjects? Decisions to issue oil and gas leases and to permit development-related activities will indirectly or directly result in the generation of noise (i.e., unwanted sound) that has the potential to impact the acoustic environment and noise-sensitive resources within and adjoining the 1002 Area. Noise-generating activities include:

- Seismic exploration;
- Exploratory drilling;
- Gravel mining;
- Construction and use of ice roads and pads, gravel roads and pads, pipelines, and other infrastructure;
- Environmental studies and other activities requiring aircraft support;
- Drilling for establishment and maintenance of production and injection wells; and
- Construction and operation of central gathering and processing plants, gas-compression plants, pump stations, and other facilities.

Of these types of development activities, gravel mining (blasting), drilling, and aircraft operations generally produce the highest levels of noise and have the potential to be audible above natural ambient sound levels and disruptive to noise-sensitive resources

up to many miles from the noise source, depending on several factors that affect noise propagation and attenuation.

Noise-sensitive resources within and adjoining the 1002 Area include:

- **Wildlife** such as caribou, polar bears, musk ox, and numerous bird species, many of which are important subsistence resources for rural residents;

- **Residents** of Kaktovik, including those engaged in subsistence activities on the coastal plain beyond the village itself;

- **Visitors** to the coastal plain; and

- **Visitors and wilderness values** in congressionally designated Wilderness that borders the coastal plain to the south and east, including opportunities to experience solitude (i.e., the absence of distractions from mechanization, noise, and unnatural light).

Several types of information are needed to understand, assess, and disclose potential impacts on the acoustic environment and noise-sensitive resources, and to provide a basis for decisions about lease stipulations and permit conditions necessary for avoiding, minimizing, or mitigating impacts to the extent possible. (For specific details regarding information needs for noise-sensitive resources themselves, see other sections that address polar bears, caribou, birds, subsistence activities and values, visitors and recreation, and wilderness values.) These information needs include:

- **Baseline (pre-development) acoustic conditions**, including natural ambient sound levels and characteristics of baseline noise conditions such as magnitude, timing, duration, and frequency of occurrence of noise events; the cumulative percent of time during which noise is audible on an hourly, daytime, and nighttime basis; and the duration of noise-free-intervals (NFI, the amount of time between two distinct noise events). The metrics used for characterizing baseline conditions should be those that are most relevant to impact assessment and mitigation, and may vary among different types of noise-sensitive resources. For example, metrics that characterize the frequency and duration of abrupt noise events loud enough to trigger disturbance responses in wildlife and metrics that characterize average hourly noise levels both may be important for describing baseline conditions. Baseline data are required for those specific time periods and specific geographic locations when and where noise from proposed development activities is expected to coincide with periods and locations of high resource sensitivity, considering factors that affect noise propagation and

attenuation. Periods and locations of particularly high resource sensitivity may include those associated with:

- Polar bear denning and cub-rearing activities;
- Caribou calving and post-calving activities;
- Migratory bird breeding and brood-rearing activities;
- Kaktovik (all periods of occupancy);
- Subsistence activities beyond Kaktovik;
- Visitor use on the coastal plain; and
- Visitor use in designated Wilderness adjoining the 1002 Area.

- **Acoustic characteristics of specific development-related noise sources**, including typical and maximum magnitude, timing, duration, and frequency of occurrence during time periods relevant to impact analysis and mitigation (analogous to an air emissions inventory necessary for predictive modeling of development-related impacts on air quality and air quality related values).

- **Modeled spatial predictions of acoustic impacts** attributable to development-related noise sources (i.e., noise propagation modeling.) Spatial noise propagation modeling is required for the purpose of estimating how development-related noise would be expected to propagate and potentially impact noise-sensitive resources depending on factors such as noise magnitude, distance from the noise source, ambient sound levels, atmospheric conditions, and landscape characteristics.

- **Disturbance-response information** that quantitatively or qualitatively characterizes relationships between noise metrics and response metrics for noise-sensitive resources including wildlife, residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness. This information is necessary for assessing, disclosing, avoiding, minimizing, and mitigating potential noise impacts to the extent possible.

  The degree to which noise disturbs and impacts wildlife and people is dependent on many factors. Wildlife responses to noise are known to vary by species, and depend on acoustic factors including the frequency, intensity / magnitude (loudness), and duration of noise; as well as on non-acoustic factors including life-history stage, environmental or behavioral context, and degree of past exposure (Francis and Barber 2013, http://dx.doi.org/10.1890/120183, full citation below). Noise that is chronic may impact sensory capabilities via masking of biologically important natural sounds such as those used for communication or detection of predators or prey. Noise that is intense and abrupt (therefore

unpredictable) may be perceived as a predation threat by prey species such as caribou, potentially triggering a startle response or antipredator behavior such as fleeing. In these cases, the type of disturbance response also may be contingent on whether the noise stimulus is accompanied by an abrupt and threatening visual stimulus, as can be the case with noise events associated with low-flying aircraft.

As with wildlife, human responses to noise also are contingent both on acoustic and non-acoustic factors. Among the non-acoustic factors are social context and perceived ability to exert control over the noise source (Stallen 1999, http://www.noiseandhealth.org/text.asp?1999/1/3/69/31712, full citation below).

The special case of aircraft disturbance. Disturbance of subsistence resources (particularly caribou) and subsistence activities by low-flying aircraft associated with oil and gas development has long been an issue of concern to North Slope residents (e.g., see Brown 1979, pp. 38-39). The level of concern has increased over time as use of aircraft to support oil and gas development, research and monitoring, recreation, and other activities on the North Slope has increased during the past few decades.

Aircraft disturbance of subsistence resources and activities is an issue that involves noise, but is one that is not solely attributable to acoustic factors. Relevant non-acoustic factors include all of those listed above for wildlife and for people. Because of the importance of non-acoustic factors, potential impacts of development-related noise on subsistence resources and activities cannot be assessed only on the basis of acoustic metrics and must be considered in relation to non-acoustic factors as well. For example, BLM staff have noted that subsistence hunters' concern with aircraft disturbance in and near NPR-A is affected by the high degree of uncertainty and unpredictability about where aircraft will be, and therefore by hunters' inability to foresee and avoid aircraft disturbance when engaged in subsistence pursuits (BLM 2017). The spatial unpredictability of aircraft disturbance contrasts with other development-related disturbances that are predictably associated with gravel roads, pads, and other forms of fixed infrastructure. Similarly, the potential spatial distribution of development-related aircraft disturbances may extend well beyond the fixed physical footprint of infrastructure.

The information needed to address this issue is a rigorous, interdisciplinary understanding of the effects of aircraft disturbance (including acoustic factors and contextual non-acoustic factors) on subsistence resources, users, and activities.

- **Long-term acoustic monitoring** to determine actual development-related impacts on the acoustic environment, determine the need for noise-mitigation measures, evaluate the effectiveness of such measures following implementation, and support adaptive management.

What information is currently available to address the information needs for subjects?

- **Baseline acoustic conditions**. During 2010, short-term baseline acoustic data were collected at two sites (Canning River West Bank and Brownlow Spit) in the extreme northwest corner of 1002 Area in support of the Environmental Impact Statement (EIS) for the Point Thomson project (see USACE 2012, Appendix O, Noise Technical Report). Relevant baseline data also were collected at a third site (Coastal Plain) located approximately 2 mi (3.2 km) west of the 1002 Area. In a study conducted in the NPR-A rather than the 1002 Area, Stinchcomb (2017) demonstrated methods for collecting baseline acoustic data, focusing on baseline characterization of NFIs and aircraft noise events in relation to subsistence resources and activities.

- **Acoustic characteristics of specific development-related noise sources**. Typical noise levels generated by individual pieces of construction equipment and specific construction operations are available online from the U.S. Department of Transportation Federal Highway Administration.
  Recent noise levels for common gas field activities (including active drilling operations) are reported by Ambrose and Florian (2014) based on field data collected in 2013 at locations near the Pinedale Anticline Project Area in Wyoming.

  Noise levels generated by different types of aircraft during different phases of flight operations are available from the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT, https://aedt.faa.gov/), a software system that models aircraft performance for the purpose of estimating emissions, noise, and fuel consumption. Aircraft noise data extracted from the FAA model, previous versions of the model, or similar sources also can be found in a number of publications. Examples include data for a Bell 206 helicopter, a Cessna 207, and a de Havilland DHC-6 Twin Otter (Miller et al. 2003); and a C-130 cargo aircraft (USACE 2004, Appendix H).

- **Modeled spatial predictions of acoustic impacts**. Currently there is no spatial noise propagation information that is specific to anticipated activities, landscape characteristics, and noise-sensitive resources in and adjoining the 1002 Area,

although methods used for the Point Thomson EIS are relevant (see USACE 2012, Appendix O, citation / link above; note that aircraft noise propagation was modeled using an FAA model that has since been replaced by the AEDT). Lacking time and technical capacity for spatial noise propagation modeling, BLM (2018) estimated propagation distances for development-related noise by assuming that noise levels would attenuate by 6 dBA for each doubling of distance from the source (Attenborough 2014). This estimation method does not account for potential effects of meteorological conditions, sound barriers, and landscape characteristics on noise propagation and attenuation.

- **Disturbance-response information**. For noise-sensitive resources in and adjoining the 1002 Area, information that relates specific disturbance responses to specific noise metrics are lacking, but several general sources of pertinent information are available. General reviews on the topic of noise disturbance on wildlife include Pepper et al. (2003), Pater et al. (2009), and Shannon et al. (2015). Frid and Dill (2002) and Francis and Barber (2013) provide theoretical frameworks for understanding noise impacts on wildlife, and risk-assessment frameworks for evaluating low-altitude aircraft impacts are provided by Efroymson and Suter (2001) and Efroymson et al. (2001). Stallen (1999) provides a theoretical framework for considering human annoyance with noise.

  Information sources with greater direct relevance to 1002 Area resources include the literature review prepared by Anderson (2007) and several specific papers on caribou responses to low-flying aircraft including Calef et al. (1976), Valkenburg and Davis (1983), and Harrington and Veitch (1991). Murphy et al. (1993; Maier et al. 1998 is the same study) investigated effects of low-altitude military jet aircraft on the Delta Caribou Herd and is the only work that includes actual noise-level data. Lawler et al. (2005) examined effects of low-altitude military jet overflights on the Fortymile Caribou Herd, focusing on the calving season.

  Blix and Lentfer (1992) measured noise and vibration levels resulting from seismic testing, drilling, and transport (including helicopters) in artificial polar bear dens in Prudhoe Bay and concluded that "…the dry and wind-beaten arctic snow muffles both sound and vibrations extremely well and it seems unlikely that polar bears in their dens will be disturbed by the type of petroleum-related activities measured here, providing those activities do not take place within 100 m of the den." But there remains a lack of good information about actual noise levels that would disturb bears in dens (T. Atwood, pers. comm., 1/26/2018).

  On the topic of aircraft disturbance of subsistence activities, Stinchcomb (2017, citation above) concluded on the basis of a meta-analysis of published literature

that "…no peer-reviewed literature has addressed the conflict between low-flying aircraft and traditional harvesters in Arctic Alaska" despite extensive evidence that such conflicts are widespread. She speculated that "…the scale over which aircraft, rural communities, and wildlife interact limits scientists' ability to determine causal relationships and therefore detracts from their interest in researching the human dimension of this social-ecological system."

Christensen and Christensen (2009) reported results of surveys conducted to determine experiences and preferences of visitors to the Arctic Refuge. Although no survey questions addressed the issue of noise *per se*, several questions addressed visitor experiences of and preferences for aircraft use for particular types of activities.

In addition to the Point Thomson EIS and the forthcoming BLM Supplemental EIS for the GMT-2 project (referenced above), other relevant information sources include impact analyses, stipulations, and best management practices included in the Integrated Activity Plan (IAP) for NPR-A (BLM 2013). Although the IAP did not address noise as a specific issue topic, noise was a factor considered in analyses conducted for several topics related to wildlife and subsistence. The Record of Decision (ROD) for the IAP includes several specific requirements for permitted aviation activities (see Best Management Practice F1, ROD pp. 65-67; also see BLM 2017, cited above) that are intended to avoid, minimize, or mitigate aircraft disturbances on wildlife and subsistence activities. These include spatial and seasonal buffers, in addition to minimum flight altitudes (contingent on flight safety considerations).

- **Long-term acoustic monitoring**. No long-term monitoring has been established in the 1002 Area for the purpose of detecting future changes in acoustic conditions and attributing such changes to particular activities including those associated with oil and gas exploration and development. Such monitoring also is lacking in the BLM-administered NPR-A and the nearby village of Nuiqsut despite public concerns over impacts of aircraft disturbance and development-related noise on village residents, subsistence resources, and subsistence activities.

What are key information gaps?

- **Baseline acoustic conditions**. Baseline acoustic data for the 1002 Area are completely lacking, with the exception of short-term data collected in the extreme northwest corner of 1002 Area in support of the Point Thomson EIS (USACE 2012). Baseline data provide a foundation for long-term monitoring that will be required to support impact mitigation and adaptive management.

- **Acoustic characteristics of specific development-related noise sources**. Although some general acoustic information is available, impact assessment and mitigation actions would benefit from specific acoustic information associated with specific development activities that are anticipated or proposed for the 1002 Area. Such information is analogous to emissions inventory data that are used to support impact analyses and mitigation requirements for air quality and air quality related values.

- **Modeled spatial predictions of acoustic impacts**. Spatial noise propagation modeling that specifically applies to anticipated / proposed development activities and specific landscape characteristics and seasonal atmospheric conditions of the 1002 Area is lacking.

- **Disturbance-response information**. Although much general information is available, specific disturbance-response information is needed to quantitatively or qualitatively characterize relationships between noise metrics and response metrics for noise-sensitive resources including wildlife (especially caribou and polar bears), residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness.

- **Long-term acoustic monitoring**. To support impact mitigation and adaptive management, long-term acoustic monitoring should be established early during the phased progression of development activities. Baseline data and long-term monitoring are required for those specific geographic locations and specific time periods where and when anticipated / proposed development activities are expected to coincide with high resource sensitivity.

In addition to key information gaps, both BLM and USFWS have significant gaps in the subject matter expertise necessary for credibly and effectively assessing and mitigating impacts of development-related noise on noise-sensitive resources of the 1002 Area.

What studies/surveys need to be conducted to fill those information gaps?

- **Baseline acoustic conditions** should be quantified for those specific geographic locations and specific time periods where and when anticipated / proposed development activities are expected to coincide with high resource sensitivity (see list above under **What we Need to Know and Why**).

- **Acoustic characteristics of specific development-related noise sources** should be determined through direct measurements of analog noise sources or should be provided by project proponents in the form of a noise emissions inventory for each phase of development.

- **Modeled spatial predictions of acoustic impacts** should be conducted for purposes of impact assessment, disclosure, and mitigation associated with proposed development activities.

- **Disturbance-response research** should be conducted to satisfy specific information needs for understanding, assessing, disclosing, and mitigating impacts of development-related noise on noise-sensitive resources. Priorities for this type of research should be identified in collaboration with subject matter experts for specific noise-sensitive resources.

- **Long-term acoustic monitoring** should be designed and implemented by BLM or USFWS staff (or appropriate cooperators / contractors) with expertise on the topics of acoustic engineering and environmental monitoring. This should be done in close collaboration with subject matter experts for specific noise-sensitive resources.

Appendix – Bibliography

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From:	Atwood, Todd
To:	Miller, Mark
Cc:	Alfredo Soto; David Payer; Davyd Betchkal; Roger Kaye; Tracy Fischbach; Kenneth (Alan) Peck; Fritz, Stacey; Arthur, Stephen; Hollis Twitchell; Burns, Casey; Debbie A Nigro; Thomas Bickauskas
Subject:	Re: For review - 1002 Area Acoustic Environment Information Needs Assessment
Date:	Tuesday, February 13, 2018 3:07:48 PM
Attachments:	1002 Acoustic Environment 2018_0211_TA.docx

Hi Mark,
Great job on this. I made a few comments re: polar bears for you to consider.

Thanks,
Todd

On Mon, Feb 12, 2018 at 8:09 AM, Miller, Mark <memiller@blm.gov> wrote:

> All -
>
> This is late in coming, but attached for your review / input is the draft information needs assessment for the 1002 Area 'Acoustic Environment' (i.e., sound / noise).
>
> The ~final submission is due to Wendy Loa and John Martin at FWS by COB Friday 16th, so I ask for your comments / input as early as possible this week, ideally no later than COB on Weds 14th. I apologize for the short turn-around. Recall that this will not be the last opportunity to provide input on information needs.
>
> Several addressees (Steve, Deb, Casey, Tom) have not previously heard from me about this topic, but I've included you on this email for informational purposes since you are identified as team members for other resource topics that are affected by this one - e.g., caribou, other wildlife, and recreation.
>
> Mark
>
> ~~~~~~
> **Mark E. Miller, PhD | Deputy Director**
> **North Slope Science Initiative** | http://www.NorthSlopeScience.org
> Email: memiller@blm.gov | Office: 907-271-3212 | Mobile: 907-231-9427
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> 222 West 7th Avenue, #13 | Anchorage, AK 99513
> ~~~~~~
> "We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely."
> -- E. O. Wilson, *Consilience*

Discipline/Subject Area: Acoustic Environment

Lead facilitator: Mark Miller, Deputy Director, BLM / North Slope Science Initiative, memiller@blm.gov, 907-271-3212

Individuals contacted:

Commented [TCA1]: You may want to note that these folks were contacted to provide subject expertise- just to be clear that there was no policy content contributed.

- Todd Atwood (Research Wildlife Biologist, USGS Alaska Science Center; tatwood@usgs.gov, 907-786-7093)
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- Tracy Fischbach (Natural Resources Planner, National Wildlife Refuge System – Region 7; tracy_fischbach@fws.gov, 907-786-3369)
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Several types of information are needed to understand, assess, and disclose potential impacts on the acoustic environment and noise-sensitive resources, and to provide a basis for decisions about lease stipulations and permit conditions necessary for avoiding, minimizing, or mitigating impacts to the extent possible. (For specific details regarding information needs for noise-sensitive resources themselves, see other sections that address polar bears, caribou, birds, subsistence activities and values, visitors and recreation, and wilderness values.) These information needs include:

- **Baseline (pre-development) acoustic conditions**, including natural ambient sound levels and characteristics of baseline noise conditions such as magnitude, timing, duration, and frequency of occurrence of noise events; the cumulative percent of time during which noise is audible on an hourly, daytime, and nighttime basis; and the duration of noise-free-intervals (NFI, the amount of time between two distinct noise events). The metrics used for characterizing baseline conditions should be those that are most relevant to impact assessment and mitigation, and may vary among different types of noise-sensitive resources. For example, metrics that characterize the frequency and duration of abrupt noise events loud enough to trigger disturbance responses in wildlife and metrics that characterize average hourly noise levels both may be important for describing baseline conditions. Baseline data are required for those specific time periods and specific geographic locations when and where noise from proposed development activities is expected to coincide with periods and locations of high resource sensitivity, considering factors that affect noise propagation and attenuation. Periods and locations of particularly high resource sensitivity may include those associated with:
    - Polar bear denning and cub-rearing activities;
    - Caribou calving and post-calving activities;
    - Migratory bird breeding and brood-rearing activities;
    - Kaktovik (all periods of occupancy);

Commented [TCA2]: Not sure that this applies. Bears will exit from land-based dens around late March, hang around on the fast ice for a short time, and then head out to the pack ice for mom to hunt. So, most post-den emergence cub rearing occurs on the ice.

- Subsistence activities beyond Kaktovik;
- Visitor use on the coastal plain; and
- Visitor use in designated Wilderness adjoining the 1002 Area.

- **Acoustic characteristics of specific development-related noise sources**, including typical and maximum magnitude, timing, duration, and frequency of occurrence during time periods relevant to impact analysis and mitigation (analogous to an air emissions inventory necessary for predictive modeling of development-related impacts on air quality and air quality related values).

- **Modeled spatial predictions of acoustic impacts** attributable to development-related noise sources (i.e., noise propagation modeling.) Spatial noise propagation modeling is required for the purpose of estimating how development-related noise would be expected to propagate and potentially impact noise-sensitive resources depending on factors such as noise magnitude, distance from the noise source, ambient sound levels, atmospheric conditions, and landscape characteristics.

- **Disturbance-response information** that quantitatively or qualitatively characterizes relationships between noise metrics and response metrics for noise-sensitive resources including wildlife, residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness. This information is necessary for assessing, disclosing, avoiding, minimizing, and mitigating potential noise impacts to the extent possible.

  The degree to which noise disturbs and impacts wildlife and people is dependent on many factors. Wildlife responses to noise are known to vary by species, and depend on acoustic factors including the frequency, intensity / magnitude (loudness), and duration of noise; as well as on non-acoustic factors including life-history stage, environmental or behavioral context, and degree of past exposure (Francis and Barber 2013, http://dx.doi.org/10.1890/120183, full citation below). Noise that is chronic may impact sensory capabilities via masking of biologically important natural sounds such as those used for communication or detection of predators or prey. Noise that is intense and abrupt (therefore unpredictable) may be perceived as a predation threat by prey species such as caribou, potentially triggering a startle response or antipredator behavior such as fleeing. In these cases, the type of disturbance response also may be contingent on whether the noise stimulus is accompanied by an abrupt and threatening visual stimulus, as can be the case with noise events associated with low-flying aircraft.

  As with wildlife, human responses to noise also are contingent both on acoustic and non-acoustic factors. Among the non-acoustic factors are social context and perceived ability to exert control over the noise source (Stallen 1999, http://www.noiseandhealth.org/text.asp?1999/1/3/69/31712, full citation below).

  The special case of aircraft disturbance. Disturbance of subsistence resources (particularly caribou) and subsistence activities by low-flying aircraft associated with oil and gas development has long been an issue of concern to

North Slope residents (e.g., see Brown 1979, pp. 38-39). The level of concern has increased over time as use of aircraft to support oil and gas development, research and monitoring, recreation, and other activities on the North Slope has increased during the past few decades.

Aircraft disturbance of subsistence resources and activities is an issue that involves noise, but is one that is not solely attributable to acoustic factors. Relevant non-acoustic factors include all of those listed above for wildlife and for people. Because of the importance of non-acoustic factors, potential impacts of development-related noise on subsistence resources and activities cannot be assessed only on the basis of acoustic metrics and must be considered in relation to non-acoustic factors as well. For example, BLM staff have noted that subsistence hunters' concern with aircraft disturbance in and near NPR-A is affected by the high degree of uncertainty and unpredictability about where aircraft will be, and therefore by hunters' inability to foresee and avoid aircraft disturbance when engaged in subsistence pursuits (BLM 2017). The spatial unpredictability of aircraft disturbance contrasts with other development-related disturbances that are predictably associated with gravel roads, pads, and other forms of fixed infrastructure. Similarly, the potential spatial distribution of development-related aircraft disturbances may extend well beyond the fixed physical footprint of infrastructure.

The information needed to address this issue is a rigorous, interdisciplinary understanding of the effects of aircraft disturbance (including acoustic factors and contextual non-acoustic factors) on subsistence resources, users, and activities.

- Brown, William E. 1979. Nuiqsut heritage: A cultural plan. Report prepared for the Village of Nuiqsut and the North Slope Borough Planning Commission and Commission on History and Culture. Arctic Environmental Information and Data Center, Anchorage. 56 pp. Available online at: https://www.blm.gov/sites/blm.gov/files/Planning_Alaska_Nuiqsut_Paisangich_Heritage_Cultural_Plan.pdf (accessed February 8, 2018).

- U.S. Department of Interior, Bureau of Land Management (BLM). 2017. BLM Arctic Office rules and actions to reduce aviation disturbance 2017. BLM Arctic District Office, Fairbanks. 8 pp. Available online at: https://www.blm.gov/sites/blm.gov/files/GetInvolved_Alaska_NPR-A_SAP_BLM_Aviation_Rules_and_Actions_to_Reduce_Disturbance.pdf (accessed February 8, 2018).

- **Long-term acoustic monitoring** to determine actual development-related impacts on the acoustic environment, determine the need for noise-mitigation measures, evaluate the effectiveness of such measures following implementation, and support adaptive management.

What information is currently available to address the information needs for subjects?

- **Baseline acoustic conditions**. During 2010, short-term baseline acoustic data were collected at two sites (Canning River West Bank and Brownlow Spit) in the extreme northwest corner of 1002 Area in support of the Environmental Impact Statement (EIS) for the Point Thomson project (see USACE 2012, Appendix O, Noise Technical Report). Relevant baseline data also were collected at a third site (Coastal Plain) located approximately 2 mi (3.2 km) west of the 1002 Area. In a study conducted in the NPR-A rather than the 1002 Area, Stinchcomb (2017) demonstrated methods for collecting baseline acoustic data, focusing on baseline characterization of NFIs and aircraft noise events in relation to subsistence resources and activities.

    - Stinchcomb, T. R. 2017. Social-ecological soundscapes: Examining aircraft-harvester-caribou conflict in Arctic Alaska. Unpublished thesis, Master of Science in Wildlife Biology & Conservation, University of Alaska Fairbanks. 90 pp. Available online at: https://scholarworks.alaska.edu/handle/11122/8143 (accessed February 9, 2018).

    - U.S. Army Corps of Engineers (USACE). 2012. Point Thomson project, final environmental impact statement. Available online at: http://www.arlis.org/docs/vol1/E/808730793/index.html (accessed February 8, 2018).

- **Acoustic characteristics of specific development-related noise sources**. Typical noise levels generated by individual pieces of construction equipment and specific construction operations are available online from the U.S. Department of Transportation Federal Highway Administration.

    - U.S. Department of Transportation (USDOT). 2006. Construction noise handbook, construction equipment noise levels and ranges. Available online at: https://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm (accessed February 8, 2018).

  Recent noise levels for common gas field activities (including active drilling operations) are reported by Ambrose and Florian (2014) based on field data collected in 2013 at locations near the Pinedale Anticline Project Area in Wyoming.

    - Ambrose, S., and C. Florian. 2014. Sound levels at greater sage-grouse leks, Pinedale Anticline Project Area, Wyoming, April 2013. Report prepared by Sandhill Company, Castle Valley, UT, for Wyoming Game and Fish Department, Cheyenne, WY. Available online at: https://www.wy.blm.gov/jio-papo/papo/wildlife/reports/sage-grouse/2013GSGacoustic-rpt.pdf (accessed February 8, 2018).

  Noise levels generated by different types of aircraft during different phases of flight operations are available from the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT, https://aedt.faa.gov/), a software

system that models aircraft performance for the purpose of estimating emissions, noise, and fuel consumption. Aircraft noise data extracted from the FAA model, previous versions of the model, or similar sources also can be found in a number of publications. Examples include data for a Bell 206 helicopter, a Cessna 207, and a de Havilland DHC-6 Twin Otter (Miller et al. 2003); and a C-130 cargo aircraft (USACE 2004, Appendix H).

  - Miller, N.P., G.S. Anderson, R.D. Horonjeff, C.W. Menge, J.C. Ross, and M. Newman. 2003. Aircraft noise model validation study, HMMH Report No. 295860.29. Report prepared by Harris Miller Miller & Hanson Inc., Burlington, MA, for National Park Service, Denver, CO. Available online at: https://www.nps.gov/grca/learn/nature/airoverflights_noisemodvalstudy.htm (accessed February 8, 2018).

  - U.S. Army Corps of Engineers (USACE). 2004. Transformation of U.S. Army Hawaii, final environmental impact statement. Available online at: https://www.garrison.hawaii.army.mil/sbcteis/feis/ (accessed February 8, 2018).

- **Modeled spatial predictions of acoustic impacts**. Currently there is no spatial noise propagation information that is specific to anticipated activities, landscape characteristics, and noise-sensitive resources in and adjoining the 1002 Area, although methods used for the Point Thomson EIS are relevant (see USACE 2012, Appendix O, citation / link above; note that aircraft noise propagation was modeled using an FAA model that has since been replaced by the AEDT). Lacking time and technical capacity for spatial noise propagation modeling, BLM (2018) estimated propagation distances for development-related noise by assuming that noise levels would attenuate by 6 dBA for each doubling of distance from the source (Attenborough 2014). This estimation method does not account for potential effects of meteorological conditions, sound barriers, and landscape characteristics on noise propagation and attenuation.

  - Attenborough, K. 2014. Sound propagation in the atmosphere. Pages 113-147 *in* T.D. Rossing (ed), Springer Handbook of Acoustics, Springer, New York (DOI: 10.1007/978-0-387-30425-0_4).

  - U.S. Department of Interior, Bureau of Land Management (BLM). 2018. NPR-A Alpine Satellite Development Plan GMT-2 Project Supplemental EIS (forthcoming, unavailable as of 2/9/2018; see GMT-2 ePlanning website).

- **Disturbance-response information**. For noise-sensitive resources in and adjoining the 1002 Area, information that relates specific disturbance responses to specific noise metrics are lacking, but several general sources of pertinent information are available. General reviews on the topic of noise disturbance on wildlife include Pepper et al. (2003), Pater et al. (2009), and Shannon et al. (2015). Frid and Dill (2002) and Francis and Barber (2013) provide theoretical frameworks for understanding noise impacts on wildlife, and risk-assessment frameworks for evaluating low-altitude aircraft impacts are provided by

Efroymson and Suter (2001) and Efroymson et al. (2001). Stallen (1999) provides a theoretical framework for considering human annoyance with noise.

Information sources with greater direct relevance to 1002 Area resources include the literature review prepared by Anderson (2007) and several specific papers on caribou responses to low-flying aircraft including Calef et al. (1976), Valkenburg and Davis (1983), and Harrington and Veitch (1991). Murphy et al. (1993; Maier et al. 1998 is the same study) investigated effects of low-altitude military jet aircraft on the Delta Caribou Herd and is the only work that includes actual noise-level data. Lawler et al. (2005) examined effects of low-altitude military jet overflights on the Fortymile Caribou Herd, focusing on the calving season.

Blix and Lentfer (1992) measured noise and vibration levels resulting from seismic testing, drilling, and transport (including helicopters) in artificial polar bear dens in Prudhoe Bay and concluded that "…the dry and wind-beaten arctic snow muffles both sound and vibrations extremely well and it seems unlikely that polar bears in their dens will be disturbed by the type of petroleum-related activities measured here, providing those activities do not take place within 100 m of the den." But there remains a lack of good information about actual noise levels that would disturb bears in dens (T. Atwood, pers. comm., 1/26/2018).

Commented [TCA3]: t may also be worth noting that that individual variation is also a factor. There have been instances over the years where bears have denned immediately adjacent to industrial infrastructure, and stayed in the den for the full term. And, there are instances where dens were abandoned early due to nearby disturbances (like ice road construction). Perhaps re-phrase this sentence to "But there remains a lack of information about noise levels that are most likely to cause bears to abandon dens"?

On the topic of aircraft disturbance of subsistence activities, Stinchcomb (2017, citation above) concluded on the basis of a meta-analysis of published literature that "…no peer-reviewed literature has addressed the conflict between low-flying aircraft and traditional harvesters in Arctic Alaska" despite extensive evidence that such conflicts are widespread. She speculated that "…the scale over which aircraft, rural communities, and wildlife interact limits scientists' ability to determine causal relationships and therefore detracts from their interest in researching the human dimension of this social-ecological system."

Christensen and Christensen (2009) reported results of surveys conducted to determine experiences and preferences of visitors to the Arctic Refuge. Although no survey questions addressed the issue of noise *per se*, several questions addressed visitor experiences of and preferences for aircraft use for particular types of activities.

In addition to the Point Thomson EIS and the forthcoming BLM Supplemental EIS for the GMT-2 project (referenced above), other relevant information sources include impact analyses, stipulations, and best management practices included in the Integrated Activity Plan (IAP) for NPR-A (BLM 2013). Although the IAP did not address noise as a specific issue topic, noise was a factor considered in analyses conducted for several topics related to wildlife and subsistence. The Record of Decision (ROD) for the IAP includes several specific requirements for permitted aviation activities (see Best Management Practice F1, ROD pp. 65-67; also see BLM 2017, cited above) that are intended to avoid, minimize, or mitigate aircraft disturbances on wildlife and subsistence activities. These include spatial and seasonal buffers, in addition to minimum flight altitudes (contingent on flight safety considerations).

- Anderson, Betty A. 2007. A Literature Review of the Effects of Helicopter Disturbance and Noise on Selected Wildlife Species. Report by ABR, Inc. 230 pp. http://catalog.northslopescience.org/catalog/entries/8591

- Blix, A. S., and J. W. Lentfer. 1992. Noise and vibration levels in artificial polar bear dens as related to selected petroleum exploration and developmental activities. Arctic 45 (1):20-24. http://www.jstor.org/stable/40511188.

- Calef, George W., Elmer A. DeBock, and Grant M. Lortie. 1976. The reaction of barren-ground caribou to aircraft. Arctic 29 (4): 201–12. http://www.jstor.org/stable/40508759.

- Christensen, Neal, and Lynette Christensen. 2009. Arctic National Wildlife Refuge visitor study: The characteristics, experiences, and preferences of Refuge visitors. Report by Christensen Research, Missoula, MT to the Aldo Leopold Wilderness Research Institute and the Arctic National Wildlife Refuge. Available online at: https://www.fws.gov/uploadedFiles/Region_7/NWRS/Zone_1/Arctic/PDF/visitorstudy.pdf (accessed February 11, 2018).

- Efroymson, Rebecca A., and Glenn W. Suter II. 2001. Ecological Risk Assessment Framework for Low-Altitude Aircraft Overflights: II. Estimating Effects on Wildlife. Risk Analysis 21 (2): 263–74. https://doi.org/10.1111/0272-4332.212110.

- Efroymson, Rebecca A., Glenn W. Suter II, Winifred H. Rose, and Sarah Nemeth. 2001. Ecological Risk Assessment Framework for Low-Altitude Aircraft Overflights: I. Planning the Analysis and Estimating Exposure. Risk Analysis 21 (2): 251–62. https://doi.org/10.1111/0272-4332.212109.

- Francis, Clinton D., and Jesse R. Barber. 2013. A Framework for Understanding Noise Impacts on Wildlife: An Urgent Conservation Priority. Frontiers in Ecology and the Environment 11 (6): 305–13. https://doi.org/10.1890/120183.

- Frid, A., and L. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6 (1): 11. http://www.ecologyandsociety.org/vol6/iss1/art11/inline.html.

- Harrington, F.H., and A.M. Veitch. 1991. Short-term impacts of low-level jet fighter training on caribou in Labrador. Arctic 44(4):318–27. http://www.jstor.org/stable/40511288.

- Lawler, J.P., A.J. Magoun, C.T. Seaton, C.L. Gardner, R.D. Boertje, J.M. Ver Hoef, and P.A. De Vecchio. 2005. Short-term impacts of military

overflights on caribou during calving season. The Journal of Wildlife Management 69 (3): 1133–46. https://doi.org/10.2193/0022-541X(2005)069[1133:SIOMOO]2.0.CO;2.

- Maier, Julie A. K., Stephen M. Murphy, Robert G. White, and Michael D. Smith. 1998. Responses of caribou to overflights by low-altitude jet aircraft. The Journal of Wildlife Management 62 (2): 752–66. https://doi.org/10.2307/3802352.

- Murphy, Stephen M., Smith, Michael D., Robert G. White, Julie A. Kitchens, Bret R. Luick, B. Andrew Kugler, and David S. Barber. 1993. Behavioral responses of caribou to low-altitude jet aircraft. Report by ABR, Inc., and the Institute of Arctic Biology, University of Alaska Fairbanks. 53 pp. Available online at: http://www.dtic.mil/dtic/tr/fulltext/u2/a292491.pdf.

- Pater, Larry L., Teryl G. Grubb, and David K. Delaney. 2009. Recommendations for Improved Assessment of Noise Impacts on Wildlife. Journal of Wildlife Management 73 (5): 788–95. https://doi.org/10.2193/2006-235.

- Pepper, Christopher B., Marc A. Nascarella, and Ronald J. Kendall. 2003. A Review of the Effects of Aircraft Noise on Wildlife and Humans, Current Control Mechanisms, and the Need for Further Study. Environmental Management 32 (4): 418–32. https://doi.org/10.1007/s00267-003-3024-4.

- Shannon, Graeme, Megan F. McKenna, Lisa M. Angeloni, Kevin R. Crooks, Kurt M. Fristrup, Emma Brown, Katy A. Warner, et al. 2015. A Synthesis of Two Decades of Research Documenting the Effects of Noise on Wildlife. Biological Reviews, https://doi.org/10.1111/brv.12207.

- Stallen, Pieter Jan M. 1999. A Theoretical Framework for Environmental Noise Annoyance. Noise and Health 1 (3): 69. http://www.noiseandhealth.org/text.asp?1999/1/3/69/31712.

- U.S. Department of Interior, Bureau of Land Management (BLM). 2013. Record of Decision, National Petroleum Reserve-Alaska Integrated Activity Plan (see IAP ePlanning website).

- Valkenburg, P., and J.L. Davis. 1983. The reaction of caribou to aircraft: A comparison of two herds. Pages 7-9 *in* Martell, A.M., and D.E. Russell (eds). Caribou and human activity. Proc. 1st North American Caribou Workshop, Whitehorse, Yukon, 28-29 Sep 1983. Canadian Wildlife Service Special Publication, Ottawa.

- **Long-term acoustic monitoring**. No long-term monitoring has been established in the 1002 Area for the purpose of detecting future changes in acoustic conditions and attributing such changes to particular activities including those

associated with oil and gas exploration and development. Such monitoring also is lacking in the BLM-administered NPR-A and the nearby village of Nuiqsut despite public concerns over impacts of aircraft disturbance and development-related noise on village residents, subsistence resources, and subsistence activities.

What are key information gaps?

- **Baseline acoustic conditions**. Baseline acoustic data for the 1002 Area are completely lacking, with the exception of short-term data collected in the extreme northwest corner of 1002 Area in support of the Point Thomson EIS (USACE 2012). Baseline data provide a foundation for long-term monitoring that will be required to support impact mitigation and adaptive management.

- **Acoustic characteristics of specific development-related noise sources**. Although some general acoustic information is available, impact assessment and mitigation actions would benefit from specific acoustic information associated with specific development activities that are anticipated or proposed for the 1002 Area. Such information is analogous to emissions inventory data that are used to support impact analyses and mitigation requirements for air quality and air quality related values.

- **Modeled spatial predictions of acoustic impacts**. Spatial noise propagation modeling that specifically applies to anticipated / proposed development activities and specific landscape characteristics and seasonal atmospheric conditions of the 1002 Area is lacking.

- **Disturbance-response information**. Although much general information is available, specific disturbance-response information is needed to quantitatively or qualitatively characterize relationships between noise metrics and response metrics for noise-sensitive resources including wildlife (especially caribou and polar bears), residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness.

- **Long-term acoustic monitoring**. To support impact mitigation and adaptive management, long-term acoustic monitoring should be established early during the phased progression of development activities. Baseline data and long-term monitoring are required for those specific geographic locations and specific time periods where and when anticipated / proposed development activities are expected to coincide with high resource sensitivity.

In addition to key information gaps, both BLM and USFWS have significant gaps in the subject matter expertise necessary for credibly and effectively assessing and mitigating impacts of development-related noise on noise-sensitive resources of the 1002 Area.

What studies/surveys need to be conducted to fill those information gaps?

- **Baseline acoustic conditions** should be quantified for those specific geographic locations and specific time periods where and when anticipated /

proposed development activities are expected to coincide with high resource sensitivity (see list above under **What we Need to Know and Why**).

- **Acoustic characteristics of specific development-related noise sources** should be determined through direct measurements of analog noise sources or should be provided by project proponents in the form of a noise emissions inventory for each phase of development.

- **Modeled spatial predictions of acoustic impacts** should be conducted for purposes of impact assessment, disclosure, and mitigation associated with proposed development activities.

- **Disturbance-response research** should be conducted to satisfy specific information needs for understanding, assessing, disclosing, and mitigating impacts of development-related noise on noise-sensitive resources. Priorities for this type of research should be identified in collaboration with subject matter experts for specific noise-sensitive resources.

- **Long-term acoustic monitoring** should be designed and implemented by BLM or USFWS staff (or appropriate cooperators / contractors) with expertise on the topics of acoustic engineering and environmental monitoring. This should be done in close collaboration with subject matter experts for specific noise-sensitive resources.

From:	Churchwell, Roy
To:	Arthur, Stephen
Cc:	Joanna Fox; Steve Berendzen; Christopher Latty; Janet Jorgenson; Burkart, Greta
Subject:	Re: 1002 resource summaries
Date:	Tuesday, February 13, 2018 3:14:36 PM
Attachments:	1002 Resouce Assessment_Caribou_RTC.docx 1002 Resource Assessment_Other Mammals_RTC.docx

---

Hello Steve,

I had just a few comments.

Roy

On Tue, Feb 13, 2018 at 10:39 AM, Arthur, Stephen <stephen_arthur@fws.gov> wrote:

> Attached are draft resource summaries for caribou and for other terrestrial mammals. Any comments would be welcome.
>
> Steve
>
> Stephen M. Arthur, Ph.D.
> *Supervisory Wildlife Biologist*
> *Arctic National Wildlife Refuge*
> *101 12th Ave., Room 236*
> *Fairbanks, AK 99701*
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--
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REPORTING TEMPLATE

- **Discipline/Subject Area: Caribou**

- **Lead facilitator:** Stephen M. Arthur, U.S. Fish and Wildlife Service, stephen_arthur@fws.gov, 907-455-1830.

- **Individuals contacted:** HeatherJohnson, USGS, heatherjohnson@usgs.gov, 907-786-7155; Brad Griffith, USGS, dbgriffith@alaska.edu, 907-474-5067; Patricia Reynolds, FWS (retired), patricia@reynoldsalaska.com, Fran Mauer, FWS (retired), fmauer@mosquitonet.com, Ken Whitten, Alaska Dept. of Fish and Game (retired), kwhitten89@gmail.com, Eric Wald, NPS, eric_wald@nps.gov, 907-455-0624.

- **What do we need to know and why regarding subjects?**

  The first three purposes of the Arctic National Wildlife Refuge, as established by the Alaska National Interest Lands Conservation Act are:

  - "to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, the Porcupine caribou herd (including participation in coordinated ecological studies and management of this herd …);
  - "to fulfill the international fish and wildlife treaty obligations of the United States";
  - "to provide the opportunity for continued subsistence uses by local residents";

  In addition, the International Agreement for the Conservation of the Porcupine Caribou Herd (1987) obligates the governments of the United States and Canada to:

  - "conserve the Porcupine Caribou Herd and its habitat through international co-operation and coordination so that the risk of irreversible damage or long-term adverse effects as a result of use of caribou or their habitat is minimized";
  - "ensure opportunities for customary and traditional uses of the Porcupine Caribou Herd" by rural Alaska residents and members of Canadian First Nations;

  Conservation of the Porcupine caribou herd in association with the exploration, development, and production of oil and gas resources on the coastal plain of the Arctic Refuge will require information regarding:

  - Importance of the 1002 Area relative to caribou birth rates, calf survival, and overall herd health;
  - Likelihood and consequences of disturbance or displacement of caribou from the 1002 Area (or portions thereof) during calving and post-calving seasons;
  - Potential impacts of development on access to caribou by hunters and on viewing opportunities of other Refuge visitors;

- **What information is currently available to address the information needs for subjects?**

Commented [CRT1]: Feel free to disregard because maybe we only want to highlight biological needs in this document. . But, has anyone studied what the importance of this herd is to the native community? Something along the lines of the socioeconomics of the Porcupine Caribou Herd. One might ask, the cost to a village (Kaktovik for example) if the caribou don't travel by that year and there is no harvest? Or, how much does harvest of a caribou (or receiving some caribou) save a family? It's probably a bit out of the scope of this document, but I am trying to figure out how to quantify the cost of getting this wrong for the native community. . and maybe it could be extended to the non-native community.

- The Porcupine caribou herd occupies a range of approximately 130,000 square mi (337,000 square km) spanning the border between Alaska and Canada. The herd is an important cultural and economic resource utilized by local and indigenous people in Alaska and the Yukon and Northwest Territories of Canada. Approximately 2,000 – 3,000 caribou are harvested annually, mostly by subsistence users. In addition, viewing the large aggregations of caribou that occur during summer is a unique experience valued by visitors from across the U.S. and around the world.
- Telemetry data from collared adult female caribou from the Porcupine herd have been collected since 1982. These data indicate that this herd migrates to the Arctic coastal plain of northeastern Alaska and northwestern Canada for calving during early June. The area used for calving for all years combined extends approximately from the Canning River in Alaska to the Babbage River in Yukon Territory, Canada and includes most of the 1002 Area of the Arctic Refuge. Additional aerial surveys conducted over the coastal plain beginning in the 1960s, and surveys of relative abundance of bone and antler specimens on the tundra dating back to the early 20th century confirm that this area has been used for calving for many decades, and likely for millennia. Annual distributions of caribou during the calving season have varied among years; however, the highest densities of calving caribou were within the central coastal plain of the Arctic Refuge during many years.
- Predator densities are lower within areas of the coastal plain used for calving compared to neighboring areas in the foothills of the Brooks Range.
- Availability of high-quality food plants consumed by caribou during the calving season is greater within the calving range than in neighboring areas to the south and east.
- Modeling the potential effects of displacement of the caribou calving range from the coastal plain suggested that this would expose caribou calves to higher rates of predation and lower quality forage.
- During 1982-1998, caribou from the Porcupine herd used the 1002 Area and neighboring coastal areas of the Arctic Refuge for insect relief habitat during late June and early July of most years. From 1999-2017 caribou moved through this area after calving but the duration of use was variable and generally shorter than during the previous period, and most caribou moved south into the Brooks Range or east into Canada during early July.
- All arctic caribou herds fluctuate in size over periods of several decades. However, the rate of change (both increase and decline) of the Porcupine herd has been slower than other herds in arctic Alaska. The herd increased slowly during the 1980s, reached a peak of 178,000 in 1989, declined to approximately 123,000 in 2001, then increased to its current population of 218,000 in 2017.
- Studies of the Central Arctic caribou herd in developed areas west of the Arctic Refuge suggested that pregnant female caribou avoided roads and other oil field

infrastructure during the calving period. Avoidance of infrastructure was less evident or absent among non-pregnant females and males. Caribou were more tolerant of human disturbance during mid to late summer, when caribou movements are largely driven by insect harassment. When human activity is low, caribou may even seek out raised gravel pads, roads, or structures to escape insect harassment.

- Prior to development, the area surrounding Prudhoe Bay was used by Central Arctic caribou for both calving and as insect relief habitat. The intensive development that occurred in this area caused caribou to shift their calving distribution southward, and to cease using the developed area for forming the large aggregations that occur in response to insect harassment. Caribou appear to be more tolerant of the lower density of infrastructure associated with more recent installations west of Prudhoe Bay and have continued to use developed areas near the Kuparuk, and Milne Point oil fields for insect relief.
- Displacement of Central Arctic caribou from preferred calving areas near Prudhoe Bay was associated with reduced calf size at birth, but the difference was not sufficient to cause a statistically detectable reduction in calf survival.
- Elevating pipelines to a minimum of seven feet above ground and separating roads and pipelines by at least 300 feet reduced the impact of linear features that might obstruct caribou movements.
- Despite any negative impacts that might have occurred during the period of development, the Central Arctic caribou herd grew from approximately 10,000 caribou in the late 1970s to a peak population of 70,000 in 2010. The herd subsequently declined to 22,000 in 2016.

➢ **What are key information gaps?**

Much of the available information regarding effects of oil field development on caribou came from studies of the Central Arctic herd during the 1980s and 1990s. These studies did not utilize the sophisticated analytical methods that have been developed since then, and most were limited to documenting large-scale distribution patterns, comparing density of caribou at varying distances from infrastructure, and observing changes in caribou numbers over time. In addition, many studies were of limited duration and had low statistical power to detect differences in demographic rates (e.g., survival, reproduction, population change). Because of the variety of factors that drive caribou demographics (e.g., variation in climate, weather, forage quality, predator abundance) and the general tendency of caribou herds to fluctuate in abundance, these studies provide only limited information to evaluate the potential impacts of development on the Porcupine caribou herd. Furthermore, there are significant geographic differences between the ranges of the Central Arctic and the Porcupine herds. For example, the coastal plain used for calving by the Central Arctic herd extends up to 100 mi (~~600~~ 161 km) inland from the Arctic coast to the foothills of the Brooks Range; whereas, the coastal plain used by the Porcupine herd

is only 10-40 mi (10-60 ~~240~~ km) wide and contains a much smaller proportion of moist and wet sedge tundra habitat used by caribou for feeding during early summer. These differences suggest that potential impacts on the Porcupine herd could be more serious due to the relative scarcity of alternative calving habitat within the range of that herd. Key information gaps include:

- Estimated rates of survival and recruitment are not sufficiently precise to detect biologically significant differences among years;
- Lack of understanding of what drives the variation in calving site selection by caribou;
- Little empirical data are available concerning the physiological and demographic effects of displacement of caribou from preferred calving and insect relief habitats (e.g., evaluate the value of the 1002 Area in providing nutrition, reduced predation, and insect relief habitat in comparison to other areas).
- Data are needed to assess effectiveness of existing measures used to mitigate effects of disturbance on caribou and to develop more cost-effective standards;
- Research is needed to differentiate the effects of disturbance from natural variation in caribou distribution, abundance, and demographic parameters;
- Limited understanding of how interchange of caribou between neighboring herds, and how interchange might affect population dynamics of those herds.

Commented [CRT2]: I'm confused how the highlighted part fits in with the first section of the sentence. First, I am not sure what standards this refers to, and second I'm not sure who the cost-effective portion should benefit (biologists, taxpayers, oil producers).

What studies/surveys need to be conducted to fill those information gaps?

- Increase monitoring intensity (number of radiocollared caribou) to improve precision of estimates of survival and birth rates and to better reveal relationships among neighboring herds. These data would also facilitate studies of the following topics;
- Identify and evaluate the relative importance of climate, predators, forage quality, and disturbance as drivers of calving site selection;
- Quantify effects of calving site characteristics (vegetation type, forage quality, predator abundance, human activity, etc.) on calf production, survival, & growth;
- Evaluate effects of winter seismic exploration on plant phenology; i.e., how snow compaction by vehicle traffic might reduce food availability for caribou during early summer.
- Analyze existing telemetry data to quantify seasonal ranges and migration routes and assess potential effects of changes in these distributions on demographics (winter vs. summer range quality, etc.);
- Investigate patterns of post-calving distribution in relation to weather and insect activity (micro habitat scale);
- Monitor body condition and survival over time to predict the expected population peak and subsequent decline.

REPORTING TEMPLATE

- **Discipline/Subject Area: Terrestrial mammals other than caribou**

- **Lead facilitator:** Stephen M. Arthur, U.S. Fish and Wildlife Service, stephen_arthur@fws.gov, 907-455-1830.
-
- **Individuals contacted:** Wendy Loya, FWS, wendy_loya@fws.gov, 907-786-3532; David Payer, NPS, david_payer@nps.gov, 907-644-3578, Patricia Reynolds, FWS (retired), patricia@reynoldsalaska.com, Fran Mauer, FWS (retired), fmauer@mosquitonet.com, Ken Whitten, Alaska Dept. of Fish and Game (retired), kwhitten89@gmail.com.

- **What do we need to know and why regarding subjects?**

The purposes of the Arctic National Wildlife Refuge, as established by the Alaska National Interest Lands Conservation Act include:

- to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, …, grizzly bears, muskox, Dall sheep, wolves, [and] wolverines, …;
- to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents,

Conservation of the mammals in the Arctic National Wildlife Refuge in association with the exploration, development, and production of oil and gas resources on the coastal plain will require information regarding:

- Importance of the 1002 Area relative to distribution, abundance, reproduction, and habitat requirements of mammal species;
- Likelihood and consequences of disturbance or displacement of mammals from the 1002 Area (or portions thereof) due to exploration and development of petroleum resources;
- Potential impacts of development on access to the area by subsistence hunters and trappers, and on viewing opportunities of other Refuge visitors;

Major mammal species or species groups of concern include:

Carnivores

- Documenting the location of grizzly bear dens near areas of on-going human activities is needed on an annual basis to avoid disturbing bears and to reduce potential human-bear conflicts. Effects of supplemental food (primarily garbage) on the distribution of bears, changes in bear behavior and rates of reproduction and growth, and the frequency of human-bear conflicts need to be monitored. Periodic density estimates for grizzly bears in the 1002 area and the neighboring

foothills will be needed to assess long-term population-level effects on bears and resulting effects on prey species.

- Studies of effects of human activities, including provision of supplemental food and construction of roads and pipelines, on populations and distributions of red and arctic foxes are needed to assess potential effects on both foxes and their prey (ground-nesting birds and rodents). Competitive relationships between fox species also need to be monitored.

- Little is known about wolf and wolverine densities and relationships with infrastructure on the North Slope. Surveys are needed to document wolf and wolverine abundance and distribution and to identify den sites.

Herbivores

- Changes in moose distribution and abundance are likely to occur as a result of shrub expansion on the coastal plain, and potential effects of winter snow conditions should be monitored to understand changes in moose populations and availability of moose for subsistence hunters.

- Abundance and density of muskoxen within the Arctic Refuge should be monitored to determine if muskoxen return to the Refuge from adjacent areas and if this is influenced by oil field infrastructure or changes in abundance and distribution of predators and other prey species.

- Distribution, abundance, and habitat associations of arctic ground squirrels should be documented. Ground squirrels are a key species in the Arctic, in that they are an important prey for many predators and can influence vegetation communities by consuming vegetation and by fertilizing the tundra around their colonies. Thus, changes in ground squirrel populations can have profound effects on local communities.

- Population levels of microtines and other small rodents should be monitored to determine the timing and magnitude of population highs and lows and how these relate to other components in the ecosystem, especially population dynamics of mesocarnivores and their alternate prey (ground-nesting birds). Effects of climate change on the distribution and dynamics of small mammals should also be investigated.

- Small mammal species (rodents and shrews) on the coastal plain should be inventoried; particularly species for which little is known, such as the holarctic least shrew. Very little is currently known about which small mammal species occur on the coastal plain, or their population status.

- The distribution and abundance of hares on the coastal plain should be documented, and species identity should be determined (snowshoe vs. Arctic hare). Hares are a key species of the boreal forest, and are likely to increase their range northward as the climate warms. This will have far-reaching effects on both vegetation and other mammals and birds.

➢ **What information is currently available to address the information needs for subjects?**

Surveys of the abundance and distribution of several mammal species were conducted during the Arctic National Wildlife Refuge Coastal Plain Resource Assessment studies of the 1980s. These included studies of muskoxen, moose, Dall's sheep, wolves, arctic foxes, wolverines, grizzly bears, arctic ground squirrels, and other rodents. Much of this information was limited to documenting the occurrence and, in some cases, estimates of abundance of these species. Since 1987, some additional surveys have been conducted to monitor abundance and distribution of muskoxen, moose, and Dall's sheep and to inventory small mammal species occurrence along the Canning River.

- Grizzly bear use of the 1002 Area varies seasonally. Bear abundance is greatest during early summer; bear density in the area at this time was estimated at 30 per square mi. Most bears that use the coastal plain move into the foothills for denning, but approximately 5% of grizzly bears den on the coastal plain. During summer, bears commonly prey on caribou, moose, muskoxen, ground squirrels, and small rodents, as well as berries and other vegetation. Across arctic North America there is evidence of increasing abundance of grizzly bears along the arctic coast; however, no data are available to determine if this has occurred in the Arctic Refuge. Denning bears are susceptible to disturbance from human activities during winter (particularly seismic exploration). Disturbance may cause bears to abandon their dens and suffer increased rates of mortality. This risk is especially high for newborn bear cubs.
- Arctic foxes are widespread and relatively common near the Arctic coast during summer. Red foxes are fairly common inland, and may be increasing in abundance along the coast. Studies in Scandinavia suggest that red foxes may outcompete arctic foxes, and may be the cause of declining arctic fox populations in some areas. The principal prey of both species during summer includes a variety of small mammals and ground nesting birds, but particularly brown and collared lemmings. Lemming populations in the Arctic cycle in abundance, with large peaks in abundance occurring approximately every 4 years, and arctic fox abundance generally cycles in response to changes in lemming abundance. There is evidence from Scandinavia that the magnitudes of these cycles have been reduced in recent years in association with a warming climate. Reduction or

Commented [CRT1]: That seems really high! Is it .3/mi2, or 30/100mi2?

elimination of fox population cycles is predicted to have negative effects on other prey species, such as ground-nesting birds. In addition, provision of supplemental food, such as garbage, is likely to increase fox abundance near industrial infrastructure, and this may reduce survival of ground nesting birds. On the North Slope, arctic foxes have a high incidence of rabies, but little is known about the relationship between disease and fox population dynamics or the potential for rabies to spread to other species.

- Wolves and wolverines are present but not abundant on the Arctic coastal plain. During the 1002 resource assessment studies of the 1980s, the locations of several wolf dens were documented. However, little is known about current wolf or wolverine abundance and distribution in the Arctic Refuge.
- Moose densities are generally low on the Refuge's coastal plain in winter, but some animals that spend the winter along drainages in the mountains use the 1002 area in summer. Survey data suggest that moose numbers along these drainages declined during the late 1980s and remained low through approximately 2010. More recent surveys suggest a moderate increase in moose abundance has occurred in areas to the east and west of the 1002 area, but little change is evident within this area.
- Muskox abundance in the Arctic Refuge peaked at approximately 300 during the mid 1990s, then declined to near zero by 2006. Since then, small groups of muskoxen have been found occasionally within the Refuge during summer; these most likely are animals that live primarily east of the Refuge in Canada or on Alaska state land west of the Canning River. The population decline was likely due to a combination of predation and other factors, including winter weather, disease, and changes in distribution of other ungulates.
- Dall's sheep do not occur in the 1002 Area but are found in the Brooks Range Mountains to the south. The eastern Sadlerochit Mountains, near the southern border of the 1002 Area, contains habitat suitable for sheep, and the species has occasionally been seen there. Sheep are sensitive to disturbance from noise and aircraft traffic, particularly during the lambing season (mid to late May). Dall's sheep populations throughout the Brooks Range peaked during the 1980s, declined steeply during the early 1990s (most likely due to adverse weather), increased slowly through approximately 2011, then declined again during 2012-2014 in association with a series of severe winters. Surveys during 2015-2017 suggested that lamb production and survival were relatively high, and the population may once again be increasing.
- Ground squirrels have a patchy distribution in the 1002 Area because denning habitat is limited by a lack of well drained soils. In areas where ground squirrels occur, they are an important source of food for foxes, bears, wolves, wolverines and weasels.
- Microtine rodents, particularly brown lemmings, are year-round residents of the 1002 Area and are an important source of food for many species including bears, wolves, foxes, and wolverines in years when they are abundant. Extreme

fluctuations in population abundance affect the abundance and distribution of lemming predators as well as predation on other species such as ground nesting birds.

- Hares have been documented in the mountains of the Brooks Range and on the arctic coastal plain further west. Presumably these are snowshoe hares from more southern distributions, but they also may be arctic hares coming from Canada. Hares are a valuable resource for predators in areas where they are abundant. Hare populations can increase quickly and can affect local vegetation communities, with cascading effects on other herbivores. The presence of hares could increase the presence of lynx, a species that was observed in the 1002 area in past years.

- **What are key information gaps?**

  - We need a greater understanding of predator/prey and competitive relationships among red and arctic foxes, lemmings, and ground-nesting birds; how these are affected by lemming cycles; and how these complex relationships may be altered by a warming climate and anthropogenic disturbance.
  - We lack current data regarding the abundance and distribution of grizzly bears; the relative importance of the 1002 area as denning habitat is unknown; improved methods are needed to reduce availability of anthropogenic foods and the resulting negative interactions with human activities.
  - Current data are needed regarding the distribution and abundance of wolves and wolverines; to document den site locations and habitat attributes; evaluate potential for disturbance or mortality related to interaction with human activities; and evaluate effects of increased access by subsistence hunters and trappers.
  - More information is needed regarding how predation, weather, disease, and nutrition influence population dynamics of muskoxen; the potential for reestablishment of muskoxen in the Refuge by expansion of neighboring populations; and the potential effects of human activities (positive: protection from predators; or negative: disturbance or displacement).
  - Are lemming cycles changing? How does this affect survival and population dynamics of ground-nesting birds? Does this moderate or increase effects of human activities?
  - We have only limited knowledge of which mammal species are present on the coastal plain; information is particularly needed for little-known species and those whose ranges are restricted to arctic tundra.

- **What studies/surveys need to be conducted to fill those information gaps?**

  - Develop methods to estimate abundance of fox and lemming populations; monitor changes over time; and assess impacts on nesting birds.

- Continue annual surveys for moose and muskoxen that systematically cover the 1002 area in late winter.
- Investigate factors limiting distribution and abundance of muskoxen on the eastern North Slope.
- Investigate the relationship between climate change, vegetation, and moose population dynamics.
- Revisit wolf dens documented during the 1980s to see if any are still being used. Wolf observations during seasonal surveys for ungulates would provide some indication of wolf packs that occupy the 1002 area.
- Record observations of wolverines and their tracks during seasonal surveys for ungulates to obtain information on relative abundance and distribution. Potential denning habitats of wolverines with kits should be mapped using satellite imagery or other methods.
- Conduct an inventory of small mammal occurrence on the coastal plain. This could be accomplished by sampling sites accessed by floating the major rivers, supplemented by visiting some upland sites accessed by helicopter or on foot.
- Map the distribution of potential ground-squirrel habitat. This may be possible from satellite imagery based on local vegetation ("green" spots often indicate the presence of squirrels) or in combination with broad-scale vegetation or soils mapping efforts.
- Monitor observations of hares and their tracks to detect potential range expansion; determine species identity of hares that are observed.

From:	Google Calendar on behalf of Roy Churchwell
To:	paul_leonard@fws.gov
Subject:	Accepted: Arctic Refuge / LCC Discussion @ Tue Feb 20, 2018 1pm - 2pm (AKST) (paul_leonard@fws.gov)
Attachments:	invite.ics

Roy Churchwell has accepted this invitation.
Arctic Refuge / LCC Discussion
Paul's Office
When Tue Feb 20, 2018 1pm – 2pm Alaska Time
Video call b5-CIP [redacted]
Calendar paul_leonard@fws.gov
Who • paul_leonard@fws.gov - organizer
• joshua_bradley@fws.gov
• laura_makielski@fws.gov
• roy_churchwell@fws.gov
• christopher_latty@fws.gov

Invitation from Google Calendar b5-CIP [redacted]
You are receiving this email at the account paul_leonard@fws.gov because you are subscribed for invitation replies on calendar paul_leonard@fws.gov.
To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.
Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More
<https://support.google.com/calendar/answer/37135#forwarding> .

From:	Churchwell, Roy
To:	Latty, Christopher
Subject:	Re: Latest
Date:	Wednesday, February 14, 2018 12:20:44 PM
Attachments:	REPORTING TEMPLATE Birds_2-14-18_RTC.docx

Chris,

This document has come a long way. It is certainly much better than the first drafts we came up with. I like it. I've made a scattering of comments. . .mostly spelling etc. Just a couple larger comments that might take a little attention.

Roy

On Tue, Feb 13, 2018 at 11:24 PM, Latty, Christopher <christopher_latty@fws.gov> wrote:

> --
> Christopher Latty
> US Fish and Wildlife Service
> Arctic NWR
> 101 12th Avenue
> Room 236
> Fairbanks, AK 99701
> cell 907-347-4300

--
Roy Churchwell, PhD
Wildlife Biologist
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Kanuti National Wildlife Refuge
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https://www.fws.gov/refuge/kanuti/

REPORTING TEMPLATE

Discipline/Subject Area: Birds

What do we need to know and why regarding subjects?

The coastal plain of the Arctic National Wildlife Refuge and adjacent marine waters (including the 1002 Area) are recognized as Important Bird Areas by the American Bird Conservancy, Audubon, and Birdlife International. Prior studies have demonstrated the value of the 1002 Area to both breeding and non-breeding birds. During the short Arctic summer ~~open water period~~ millions of shorebirds, waterfowl, loons, other waterbirds, and landbirds use the 1002 Area. At least 158 species of birds have been recorded on the Arctic Refuge Arctic Coastal Plain (ACP) and birds that use the Refuge have ranges that include all 50 U.S. states and six continents. Of the 57 species that regularly occur in the 1002 Area, 25 are USFWS Birds of Management Concern, 14 are USFWS Alaska Region Priority Species, and 11 are listed as Near Threatened or Vulnerable by the International Union for Conservation of Nature or are on the Audubon Red List. Two species listed under the provisions of the Endangered Species Act have been reported in the 1002 Area, although only spectacled eiders are known to breed there.

Commented [CRT1]: How about "summer" here. There are lots of birds that use the 1002 area before there is open water, and landbirds in the 1002 aren't dependent on open water anyway.

The first three purposes of the Arctic National Wildlife Refuge, as established by the Alaska National Interest Lands Conservation Act are:

- "to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to...snow geese, peregrine falcons and other migratory birds";
- "to fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats";
- "to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents";

Applicable international treaties include the Migratory Bird Treaty. Other authorities under which we manage and conserve birds on Arctic Refuge include the Endangered Species Act, the Bald and Golden Eagle Protection Act, and the Refuge Administration Act of 1966 as amended by the Refuge Improvement Act of 1997.

Conservation of birds in association with exploration, development, and production of oil and gas resources in the 1002 Area of the coastal plain of the Arctic Refuge will require information regarding:

- Contemporary abundance and distribution of breeding and non-breeding birds in the 1002 Area, with particular attention ~~on~~ to identification of important nesting, feeding, and molting areas;
- Phenology of seasonal movement patterns by breeding and non-breeding birds in the 1002 Area;
- Impacts of development and disturbance to birds using the 1002 Area during sensitive time periods, with special consideration given to how the dissimilarities in water availability between the 1002 Area and areas like Prudhoe Bay and National Petroleum Reserve – Alaska (NPR-A) may lead to differential impacts; and
- How impacts to birds from development may affect the availability and quality (e.g, changes in tissue contaminant burdens) of birds as subsistence resource for rural Alaskan communities.

Commented [CRT2]: Just checking, was assessment of predators left off this list on purpose? I see it comes in later in the document. After reading the whole document, I see that this is probably included under the 3rd bullet, but is not singled out.

What information is available to address information needs and what are the remaining gaps?

1. Resource Inventories

Bird abundance and distribution information within the 1002 Area will help define the areas that are most important for species, or groups of species, and can therefore help define conservation and management priorities. ~~This~~ These data will also allow for comparisons of distribution and habitat use between the 1002 Area and areas of much higher wetland density to the west, like NPR-A and Prudhoe Bay.

1.1 Early Surveys for breeding and non-breeding birds

Surveys in the late 1970s through mid-1980s in the 1002 Area included site-specific ground-based tundra breeding bird surveys on the coast and inland, breeding- and post-breeding bird surveys on barrier islands and lagoons, aerial breeding swan surveys, aerial- and ground-based breeding raptor surveys, and post-breeding snow goose surveys. Although these data provide important historical information about the bird resources of the 1002 Area, abundance and distribution for many species has changed on the broader Alaska coastal plain over the intervening 40 years, and therefore likely has changed in the 1002 Area.

1.2 More Recent Surveys of breeding birds

- Ground-based shorebird surveys were conducted summer 2002 and 2004. That work found higher shorebird density in wetlands and near the Canning River Delta. Although surveys were informative, some species were encountered in low numbers making abundance estimates unreliable.
- Aerial surveys of waterbirds, including waterfowl, loons, and gulls, have been conducted annually since the mid-1980s across much of the Alaska coastal plain. However, only about 1/4th of the 1002 Area is surveyed, and survey intensity is low, leading to < 0.5% coverage of the 1002 Area.
- Aerial breeding bird surveys (primarily for common eiders) were conducted on barrier islands in summer 1999-2009. Ground-based surveys were conducted in summer 2003/04 and 2014-17. Ground surveys revealed breeding common eider abundance on the barrier islands increased by over 25-fold between 1976 and 2015.
- Breeding cliff-nesting raptors were periodically surveyed in the Brooks Range, foothills, and 1002 area ~~a few times~~ in the 1990s and early 2000s. Overall abundance of raptor nests was generally low in the 1002 Area, but breeding raptor populations fluctuate significantly between years.

1.2.1 Site-specific surveys of breeding birds in areas identified in earlier surveys as important

The only long-term or contemporary fine spatial scale breeding bird data for the 1002 Area is a single site at the Canning River Delta. Intensive surveys focused on shorebird breeding abundance were conducted semi-regularly between 1979 and 2011. Some waterbird and passerine abundance data were also collected. This site has provided significant information on fine scale habitat use patterns and phenology of tundra nesting shorebirds, passerines, waterfowl, and loons in the 1002 Area. It has also provided information on trends in abundance for some of the more common species thought to breed in the 1002 Area, including an apparent 20-fold increase in cackling geese since 1980.

1.3 More Recent Surveys of non-breeding birds

- Boat- and ground-based coastal shorebird surveys were conducted during fall staging and migration at the major river deltas, 2006-2011. These investigations found the vast majority of shorebirds using the surveyed deltas were juveniles.
- Aerial fall-staging snow geese surveys occurred in the 1990s and early 2000s. Up to 325,000 snow geese were estimated to use the Arctic Refuge coastal plain in some years.

Commented [CRT3]: Already state this with the use of periodically earlier in the sentence.

- Lagoon and near-shore surveys of post-breeding and molting waterbirds were conducted during fall 2002-2003. Up to 20, 28, 29, 33, and 41% of the yellow-billed loons, red-throated loons, long-tailed ducks, scaup, and pacific loons, respectively, counted during the entire Alaska coastal plain survey occurred along the Arctic Refuge Coast.
- Adults of three species of shorebirds were tagged in summer 2017 at four sites on the ACP (including two species at one site in the 1002 Area) with GPS loggers to track use of stopover sites along the Beaufort Sea coast, but tagging of more individuals and species is needed before assessments can be completed.

1.2.2 Resource inventory gaps for breeding and non-breeding birds

Although the abundance data for breeding and non-breeding birds in the 1002 Area has demonstrated the importance of the Refuge coastal plain, contemporary data are~~is~~ generally lacking. Most of the current information on bird abundance and distribution in the 1002 Area is dated, only collected for one or two years, covers only a small portion of the 1002 Area, and/or was collected at very low survey intensity. Given declines for many shorebirds at the species or sub-species level, increases for some goose species broadly across the North American Arctic, and potential changes to 1002 Area habitat due to climate change, updates to our understanding of bird abundance and distribution patterns in the 1002 Area ~~is~~ are needed. Also, because the 1002 Area contains far fewer waterbodies compared to sites further west, like NPR-A, it is likely bird distribution is ~~highly heterogeneous~~congregated in patches on the Arctic Refuge coastal plain. Work should focus on identifying key 1002 Area sites used by breeding birds and staging adult shorebirds; updating information on staging snow geese and waterbirds inhabiting the lagoons in fall; and determining post-breeding 1002 Area habitat use for priority and at-risk species. Because of high inter- and intra-annual variability, these baselines should be collected over multiple years.

Commented [CRT4]: With large areas without water, I am not sure heterogeneous is the best descriptor here.

2. Phenology

The timing of key life events (phenology) is a critical part of nearly every important ecological relationship. For Arctic breeding birds, timing is everything. 1002 Area birds make decisions about when to arrive, nest, brood their young, and stage prior to migration based on coinciding with availability of critical resources. Understanding bird phenology in the 1002 Area may allow exploration and development activities to occur during periods when birds are less reliant on specific areas and habitats.

<u>2.1 Status of phenology information for 1002 Area birds</u>

- A large amount of information on the timing of breeding is available for tundra-nesting birds from across the Alaska coastal plain, and can reasonably be extrapolated to the 1002 Area.
- Data ~~is~~ are available on the phenology of juvenile shorebird use of 1002 Area deltas from the surveys above, though there were substantial differences in the timing ~~between~~ among sites.
- Some information on the phenology of molting sea ducks and waterbird use of lagoons is available from studies in the 1980s, but surveys were generally only conducted a few times across several months, therefore the range ~~for~~ in timing of peak use is not known.
- Reasonably good data ~~is~~ are available on the phenology of snow geese using 1002 Area tundra during fall through the early 2000s.
- In addition to surveys, waterbird telemetry studies from sites further to the west on the Alaska coastal plain may be applicable to the phenology of these species in Arctic Refuge lagoons.
- Adults of a few shorebirds species were tagged in summer 2017 with GPS loggers and transmitters. These devices will provide phenology data across the annual cycle.

2.1.1 Information gaps for bird phenology

- In general there is good information from previous studies within and adjacent to the 1002 area for the phenology of breeding birds and post-breeding snow geese and juvenile shorebirds along the delta, but a comprehensive survey plan is appropriate to assess impacts of energy development.
- We have little golden eagle and other raptor phenology data for the 1002 Area. Because these species may occur on the coastal plain in late winter, they may be impacted by exploration.
- Although surveys have demonstrated the importance of the Refuge lagoons for waterbirds, we have a poor understanding of the phenology of this habitat. In addition, climate-mediated changes to the Beaufort Sea nearshore areas may be affecting benthic prey communities and therefore the timing of when birds use the lagoons.
- Surveys have provided reasonable phenology estimates for post-breeding juvenile shorebirds, but because few adults were encountered, adult post-breeding phenology is poorly understood and so far, few have been fitted with tracking devices that provide movement data along the Beaufort Sea coast.
- Residency time is still lacking for most birds using the 1002 Area. These~~is~~ data ~~is~~ are important in calculating disturbance or displacement risk and determining seasonal abundance estimates.

Commented [LCC5]: Added by BLM.

3. Potential impacts of development and disturbance

Numerous studies on the impacts of development and disturbance to nesting and non-breeding birds have been conducted at Prudhoe Bay and in NPR-A since the 1970s. Additionally, several studies on the potential impacts of industrialization and disturbance to birds were conducted in the 1002 Area. These studies advanced our understanding of potential impacts, but were often limited in scope and provide incomplete insights to complex ecological and management questions. Results of specific projects can be found in ~~summaries~~ summary documents, including the Arctic National Wildlife Refuge Coastal Plain Resource Assessments and Updates (e.g., Garner and Reynolds 1986, Garner and Reynolds 1987), Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries (Douglas et al. 2002, Pearce et al. 2018), and the National Research Council report on the cumulative environmental effects of oil and gas activities on Alaska's North Slope (National Research Council 2003).

3.1 Information gaps for potential impacts of development and disturbance

- Before an assessment of potential impacts of development can be conducted, better information on abundance, distribution, habitat use, and phenology of breeding and non-breeding birds in the 1002 Area is required. Therefore, the topics below only address the most apparent immediate needs.
- Exploration and development activities on the Alaska coastal plain generally require substantial volumes of freshwater, but the 1002 Area contains < 1/10 the density of lakes as areas to the west where oil and gas activities are ongoing. Also, 1002 Area lakes tend to be shallower and freeze to the bottom during winter. Therefore, wetlands and waterbodies, especially where clustered, are a precious commodity to the birds inhabiting the 1002 Area. Because of this, activities that affect the availability, seasonality, or flow of water could have different effects on birds, their habitats, and their foods in the 1002 Area compared to areas further to the west, but how and to what extent is unknown.
- Changes in the avian predator community makeup, predator abundance, and impact to avian productivity have been some of the most commonly described consequences of industrial activity for birds breeding on the Alaska coastal plain, but little is known about predator community makeup or abundance in the 1002 Area. Because red fox are thought to take advantage of anthropogenic corridors and Arctic fox have been found to change winter range in response to human activity,

gathering baseline data on predator abundance, distribution, range, and prey preferences in the 1002 Area should occur as soon as possible, preferably before exploration occurs.

- Little contemporary baseline exposure data are~~is~~ available for contaminants related to oil and gas development and activities for birds in the 1002 Area.

What studies/surveys need to be conducted to fill those information gaps? (order represents approximate ranking of prioritization)

- Conduct intensive breeding season aerial- or ground-based surveys of waterbirds, shorebirds, and landbirds throughout the 1002 Area ~~to~~ including aerial surveys similar to current surveys conducted by USFWS Migratory Birds Division, ground-based shorebird surveys, and site-specific surveys including the breeding season Canning River Delta camp. This will provide contemporary information on distribution and abundance and to identify key areas birds rely upon. Prioritization of surveys should be based on conservation needs. These surveys should be structured to provide complete coverage, but survey intensity stratified based on habitat, areas estimated to more likely be impacted by industrial water use, and if known, likely sites of future lease sales and oil and gas development. Both area wide and site-specific surveys should be conducted. Because this information may be important to leasing, and because inter- and intra-annual variability will require baseline data to be collected over several years, surveys should begin as soon as possible.
- Conduct surveys to estimate abundance, distribution, and phenology of nest predators throughout the 1002 Area. Additionally, studies should be conducted to identify nest predators and determine baseline movement patterns of 1002 Area foxes. Because some predators (such as foxes) may use winter corridors created during exploration or change seasonal movement patterns in response to development activities, these surveys and studies should occur as soon as possible.
- Conduct ground or aerial surveys of Brooks Range and foothill rivers for cliff-nesting raptor nests. Non-cliff nesting raptors that nest in the 1002 Area (snowy owl, short-eared owl, northern harrier, and rough-legged hawk) should be inventoried in the surveys described in previous bullets, but they could also be tracked using the methods described below. Where practical, these efforts should be combined with studies using the latest tracking technologies to determine how eagles and other raptors currently use the 1002 Area. Because raptors may begin using the coastal plain while winter exploration activities occur, these surveys/studies should begin as soon as possible.
- Use the latest tracking technologies to identify core areas and determine post-breeding habitat use and phenology of lagoons by waterfowl and loons and deltas and coastal areas by adult shorebirds. Prioritization should be based on species conservation need and potential impact of development.
- Investigate how differences in water availability and patchiness of habit in the 1002 Area may affect the transferability of industrialization effect studies conducted in areas to the west where waterbody density is much greater and high quality habitat is available across broad regions ~~to the Arctic Refuge coastal plain~~.
- Conduct aerial surveys of lagoons in fall to determine abundance and distribution of molting sea ducks and use by other waterbirds. When possible, timing of these surveys should be based on information provided from tagging studies. Because traditional aerial surveys are generally temporally limited for logistical and cost reasons despite substantial inter- and intra-season variability in peak abundance, where practical unmanned aerial vehicles should be considered to allow for regular sampling across the seaso~~a~~n at high-density sites.
- Conduct studies ~~on how individuals within~~ on the foraging ecology of nest predators and how individuals ~~populations~~ choose food items and adjust ~~those~~ diet patterns based on alternative prey. Objectives should target ways to inform potential management actions if ~~predator~~ local predator abundance is found to increase post-human activities ~~with minimum take~~.

Commented [LCC6]: Please add your rough estimates of cost and duration for those you are most familiar with (Wendy and the managers asked for this).

Commented [LCC7]: Wendy asked that the list represent prioritization based on

- What data are essential for identifying existing high value habitat in the next 2-4 months (best available science) and are human/financial resources needed to compile that information?
- What data are essential for identifying high value habitat (making better available science) in the next 2-3 years and what human/financial resources needed to compile that information?
- what on the list could be included in existing efforts this year with no or some additional $ resources?
- We ll be sharing one or more possible timelines for activities in the next weeks, but are there any studies that have to be done before seismic occurs?

So please add your thoughts

Commented [CRT8]: Do you have Stephen's budget for PRISM? I can send it to you if you don't. I may have some budgets from my PhD days, if that is helpful, however, you probably have a good idea of how much it costs to boat up and down the Beaufort at this point.

Commented [LCC9]: So there are really 3 surveys included here. Mig bird aerial, ground-based shorebird, and site-specific (ie Canning River Delta). Should these be broken out? I'm inclined to simply add sub-bullets for each and add an estimated price tag (Wendy and the Refuge managers asked me to try and do this if at all practical).

Commented [CRT10]: Chris, I don't know if this is the best place for this. It might be worth bringing up since these species are the most likely to be impacted though. Maybe this should go under one of the other bullets though.

- Update baseline contaminant exposure information for birds breeding in the 1002 Area and using deltas and lagoons for fall staging, with particular emphasis on hydrocarbon exposure and how contaminant burdens may affect subsistence value.
- The above studies ~~shoule~~ should incorporate and address potential impacts from climate change to birds in the 1002 Area.
- Much of the data from surveys and studies conducted in the 1002 Area are not widely available. Arctic Refuge is working with FWS Science Applications to build a publically accessible database for the long-term dataset for the Canning River Delta tundra nesting bird project. Comparable efforts should follow for other projects to ensure appropriate storage and management of important data and allow for public data access to both contemporary and historic data.

Commented [LCC11]: This was added by BLM, but I'll make sure to run it by Deb Nigro when she gets back.

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From:	Latty, Christopher
To:	Churchwell, Roy
Cc:	Fox, Joanna; Stephen Arthur; Janet Jorgenson; Burkart, Greta
Subject:	Re: USFWS referencece
Date:	Wednesday, February 14, 2018 3:55:28 PM
Attachments:	2002 Douglas.pdf InfoMemo-USGS Res Conducted in 1002 Area & NPRA 19Jan2018.pdf Pearce et al. OFR 2018-1003.pdf

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Hi Steve,

The ones I was familiar with are highlighted in the documents. Let me know if you prefer a different format.

And I'm assuming someone at Mig Birds is also including all there reports/pubs for this exercise, but don't know this for sure...

Cheers
Chris

On Wed, Feb 14, 2018 at 1:36 PM, Churchwell, Roy <roy_churchwell@fws.gov> wrote:

> Hello Steve,
>
> I looked through the second document since that covers the time frame that I am familiar with. I pasted the USFWS references into the attached document. I don't know everyone, and so I am sure that I missed a few, but what I know is included.
>
> Roy
>
> On Wed, Feb 14, 2018 at 11:56 AM, Fox, Joanna <joanna_fox@fws.gov> wrote:
>
>> Hi Steve,
>>
>> Will you please coordinate with our biological staff to provide a single response back to John Trawicki no later than 3 pm this afternoon (earlier if possible)? He wants us to identify each reference within the 3 reports he sent that was either authored or co-authored by USFWS. Please copy me and Steve B. your response.
>>
>> If you have questions or need additional information, it would probably be best to call John directly.
>>
>> Thank you!
>> Joanna
>>
>> ______________________________
>> Joanna L. Fox
>> Deputy Refuge Manager
>> Arctic National Wildlife Refuge
>> 101 12th Avenue, Room 236
>> Fairbanks, AK 99701
>> (907) 456-0549
>>
>> Follow us on Facebook!
>> www.facebook.com/arcticnationalwildliferefuge

“Do what you can, with what you have, where you are.” -- Theodore Roosevelt

---------- Forwarded message ----------
From: **Trawicki, John** <john_trawicki@fws.gov>
Date: Wed, Feb 14, 2018 at 11:41 AM
Subject: USFWS referencece
To: Joanna Fox <joanna_fox@fws.gov>

My apologies:

The two linked documents are the two USGS reports, summarizing Work on the North Slope and Refuge. The attachment is another reference document.

Could you please indicate references within these reports that are authored by USFWS.

Thank you

https://pubs.er.usgs.gov/publication/bsr20020001

https://pubs.er.usgs.gov/publication/ofr20181003

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John Trawicki
Water Resources Branch Chief
National Wildlife Refuge System, Alaska
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503
Work: (907) 786-3474
Mobile: (907) 360-1656

"The single biggest problem with communication is the illusion that it has taken place"
George Bernard Shaw

--
Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
101 12th Ave. Room 206
Fairbanks, AK 99701
(907) 456-0450

https://www.fws.gov/refuge/kanuti/

--
Christopher Latty
US Fish and Wildlife Service
Arctic NWR
101 12th Avenue
Room 236
Fairbanks, AK 99701
cell 907-347-4300

approximately 9-20% if aircraft disturbed birds at least once every 2 hours (Davis and Wiseley 1974).

Brackney (1987) estimated that 20-30 aircraft overflights/day would reduce fat reserves of juvenile snow geese on the Arctic Refuge by up to 50%, assuming geese were unable to increase feeding time to compensate for disturbance. Aircraft disturbance would likely have a greater affect on juvenile snow geese because they spend a higher proportion of the day feeding, accumulate fat reserves at a slower rate, and depart with smaller reserves than adults.

Displacement of geese from feeding areas on the Arctic Refuge is of special concern because feeding habitats are limited (Hupp and Robertson 1998) and a large proportion of the frequently used region is within the 1002 Area (Robertson et al. 1997). The Western Arctic population requires access to the entire staging area on the Arctic Refuge to ensure that it can locate adequate feeding habitat in all years. We cannot assume that snow geese would be able to locate adequate feeding habitat in other regions if they were displaced from the Arctic Refuge coastal plain.

Aircraft activity on the Arctic Refuge coastal plain east of the Hulahula River should be closely managed in the event of petroleum development. During autumn staging, aircraft should be restricted within 6 km of frequently used areas between the Okpilak and Aichilik rivers. Aircraft should be restricted across the entire staging area in years when ≥100,000 snow geese are observed on the Arctic Refuge. Surface facilities should not be placed in areas that are frequently used by snow geese.

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INFORMATION/BRIEFING MEMORANDUM

DATE: January 19, 2018
FROM: Aimee M. Devaris, Alaska Regional Director, U.S. Geological Survey
SUBJECT: Bibliography of USGS Research Conducted in the Arctic National Wildlife Refuge (ANWR) 1002 Area and/or the National Petroleum Reserve – Alaska (NPRA) as of 1/18/2018

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Summary of Wildlife-Related Research on the Coastal Plain of the Arctic National Wildlife Refuge, Alaska, 2002–17

Open-File Report 2018–1003

U.S. Department of the Interior
U.S. Geological Survey

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U.S. Department of the Interior
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U.S. Department of the Interior
RYAN K. ZINKE, Secretary

U.S. Geological Survey
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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
	Area	
square kilometer (km^2)	0.3861	square mile (mi^2)
	Flow rate	
meter per year (m/yr)	3.281	foot per year ft/yr)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32.$$

Summary of Wildlife-Related Research on the Coastal Plain of the Arctic National Wildlife Refuge, Alaska, 2002–17

By John M. Pearce,[1] Paul L. Flint,[1] Todd C. Atwood,[1] David C. Douglas,[1] Layne G. Adams,[1] Heather E. Johnson,[1] Stephen M. Arthur,[2] and Christopher J. Latty[2]

Abstract

We summarize recent (2002–17) publicly available information from studies within the 1002 Area of the Arctic National Wildlife Refuge as well as terrestrial and coastal ecosystems elsewhere on the Arctic Coastal Plain that are relevant to the 1002 Area. This report provides an update on earlier research summaries on caribou (*Rangifer tarandus*), forage quality and quantity, polar bears (*Ursus maritimus*), muskoxen (*Ovibos moschatus*), and snow geese (*Chen caerulescens*). We also provide information on new research related to climate, migratory birds, permafrost, coastal erosion, coastal lagoons, fish, water resources, and potential effects of industrial disturbance on wildlife. From this literature review, we noted evidence for change in the status of some wildlife and their habitats, and the lack of change for others. In the 1002 Area, muskox numbers have decreased and the Porcupine Caribou Herd has exhibited variation in use of the area during the calving season. Polar bears are now more common on shore in summer and fall because of declines in sea ice in the Beaufort Sea. In a study spanning 25 years, there were no significant changes in vegetation quality and quantity, soil conditions, or permafrost thaw in the coastal plain of the 1002 Area. Based on studies from the central Arctic Coastal Plain, there are persistent and emerging uncertainties about the long-term effects of energy development for caribou. In contrast, recent studies that examined direct and indirect effects of industrial activities and infrastructure on birds in the central Arctic Coastal Plain found little effect for the species and disturbances examined, except for the possibility of increased predator activity near human developments.

Background

In 2002, the U.S. Geological Survey (USGS) published a summary of terrestrial wildlife research that was conducted from the 1980s to 2001 in northeastern Alaska, including the 1002 Area of the Arctic National Wildlife Refuge (Douglas and others, 2002). The report focused primarily on wildlife within the 1002 Area, but also included information from adjacent areas of the Arctic Coastal Plain where oil development took place during the preceding 30 years. Since that report was published, the Arctic has continued to warm at more than twice the global rate (Intergovernmental Panel on Climate Change, 2014) and some wildlife species and habitats are responding to climate-induced alterations that include loss of summer sea ice and permafrost thaw, as well as altered nutrient and hydrologic cycling (Chapin and others, 2014; Marcot and others, 2015; Van Hemert and others, 2015).

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There has also been renewed interest in oil and gas development across the Arctic Coastal Plain of Alaska and offshore in the Outer Continental Shelf region of the Chukchi and Beaufort seas. As a result, substantial research has been conducted in the region in recent years to better understand the mechanisms driving changes in animal abundance and distribution, to provide scientific information for natural resource management agencies, and to guide energy development while reducing potential effects on wildlife and habitat.

Here, we provide an update of Douglas and others (2002) by summarizing recent (2002–17) scientific literature from studies within the 1002 Area of the Arctic National Wildlife Refuge and from terrestrial and coastal ecosystems elsewhere on the Arctic Coastal Plain of Alaska that are relevant to the 1002 Area. This report is organized using the same section titles that appeared in Douglas and others (2002), as well as new sections that describe related wildlife and habitat research within or adjacent to the 1002 Area. The new sections include climate, migratory birds, permafrost, coastal erosion, coastal lagoons, fish, and water resources. In the caribou and migratory bird sections, we summarize recent studies regarding the potential effects of industrial disturbance on wildlife. This report also updates and complements information presented in a USGS report on the natural resources and science needs in the Arctic Outer Continental Shelf region (Holland-Bartels and Pierce, 2011).

Study Area

The 1002 Area of the Arctic National Wildlife Refuge is a 1,500,000 acre (6,100 km^2) area in northeastern Alaska (fig. 1). The approximate boundary of the 1002 Area is bounded on the north by the Beaufort Sea, on the west by the Canning River, and the east by the Aichilik River. The southern boundary follows the approximate 1,000-foot (305-m) elevation contour (Clough and others, 1987). The area is predominantly coastal tundra and upland habitat, often referred to as the ‘coastal plain’, and includes offshore barrier islands and lagoons (fig. 1). The 1002 Area comprises about 75 percent of the total coastal plain of the Arctic National Wildlife Refuge (Clough and others, 1987). Additional study area details can be found in Douglas and others (2002) and U.S. Fish and Wildlife Service (2015a).

Climate conditions of the 1002 Area and surrounding region have changed over recent decades. Jorgenson and others (2015a) reported that the mean annual temperature at the Kuparuk weather station, 190 km west of the 1002 Area, increased by 2.5 °C between 1984 and 2009. Gustine and others (2017) determined that from 1970 to 2013, average air temperatures during the growing season along the Dalton Highway, from the Brooks Range to Prudhoe Bay, showed long-term upward trends, with the greatest increase recorded in the coastal plain near Prudhoe Bay. The rapid increase in May air temperature has driven a trend in markedly earlier snow melt dates, which advanced by about 10 days between 1941 and 2004, leading to a longer growing season (Hinzman and others, 2005). Gustine and others (2017) also determined that day of spring ground thaw (≥0 °C) occurred 8 days earlier (range = 2–13 days) and the length of the vegetation growing season was 11 days longer (range = 0–20 days) in 2013 than in the 1970s. Warmer air temperatures have been accompanied by warmer near-surface water temperatures along the coast, which increased by 1.0–1.5 °C from 2007 to 2011 relative to the 1982–2011 long-term mean (Stroeve and others, 2014). Warmer air and ocean temperatures have altered sea ice extent and phenology, causing the annual number of days the southern Beaufort Sea was covered by ice to decrease at a rate of -17.5 days per decade from 1979 to 2014 (Stern and Laidre, 2016). Since the late 1990s, the mean duration of the open-water season (that is, period of time when sea ice is largely absent from the biologically productive continental shelf) has increased by 36 days (Atwood and others, 2016).

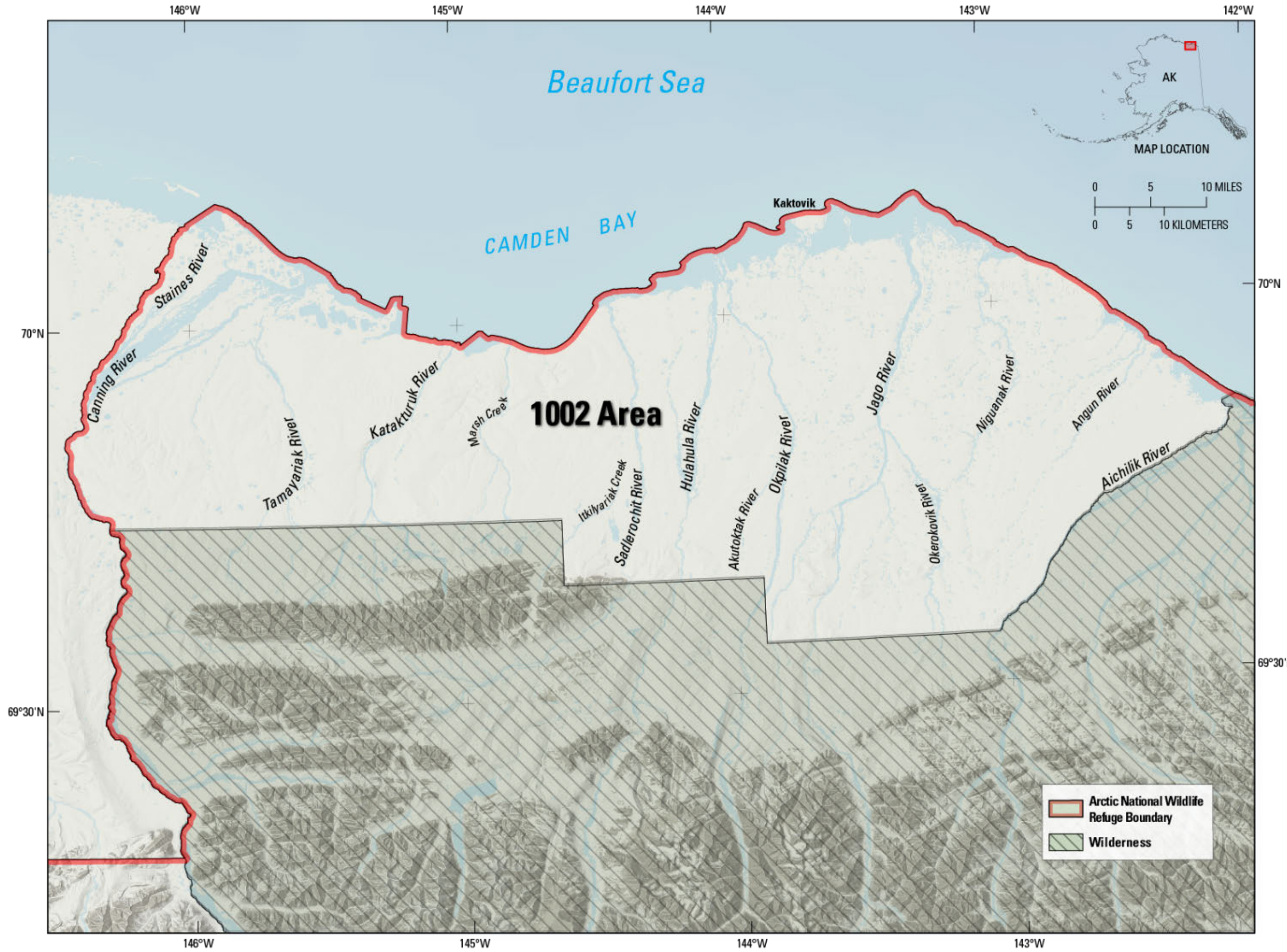

Figure 1. Map of 1002 Area showing approximate boundaries and main rivers, Arctic National Wildlife Refuge, Alaska. Detailed land ownership is not shown. Data source: Bureau of Land Management and Bureau of Ocean Energy Management.

Urban and Clow (2017) provide climate monitoring data collected from August 1998 to July 2015 from an array of 16 monitoring stations across the North Slope of Alaska that span latitude 68.5°N. to 70.5°N. and longitude 142.5°W. to 161°W. Three of the monitoring stations (Niguanak, Marsh Creek, and Camden Bay) are in the 1002 Area. Data collection at these stations is ongoing and includes the following climate- and permafrost-related variables: air temperature, wind speed and direction, ground temperature, soil moisture, snow depth, rainfall totals, up- and downwelling shortwave radiation, and atmospheric pressure.

Land Cover

The land-cover map in Jorgenson and others (2002) has not been updated for the 1002 Area, but there have been new releases of land cover information for the entire state of Alaska and North Slope region (Jorgenson and Heiner, 2003; Jorgenson and Grunblatt, 2013; Boggs and others, 2016; Raynolds and others, 2017). Nevertheless, the Jorgenson and others (2002) product remains the highest spatial resolution digital land cover map for the 1002 Area.

Porcupine Caribou Herd

The Porcupine Caribou Herd migrates between Alaska and the Yukon and Northwest Territories of Canada (fig. 2; Caikowski, 2015). Detailed information on herd range characteristics can be found in U.S. Fish and Wildlife Service (2015a). Griffith and others (2002) reported the herd size as 123,000 in 2001. Estimates of population size for the Porcupine Herd were not available between 2002 and 2009, but photocensuses in 2010, 2013, and 2017 demonstrated an increasing trend in population estimates with 169,000, 197,000, and 218,457 caribou counted, respectively (McFarland and others, 2017; Alaska Department of Fish and Game, 2018).

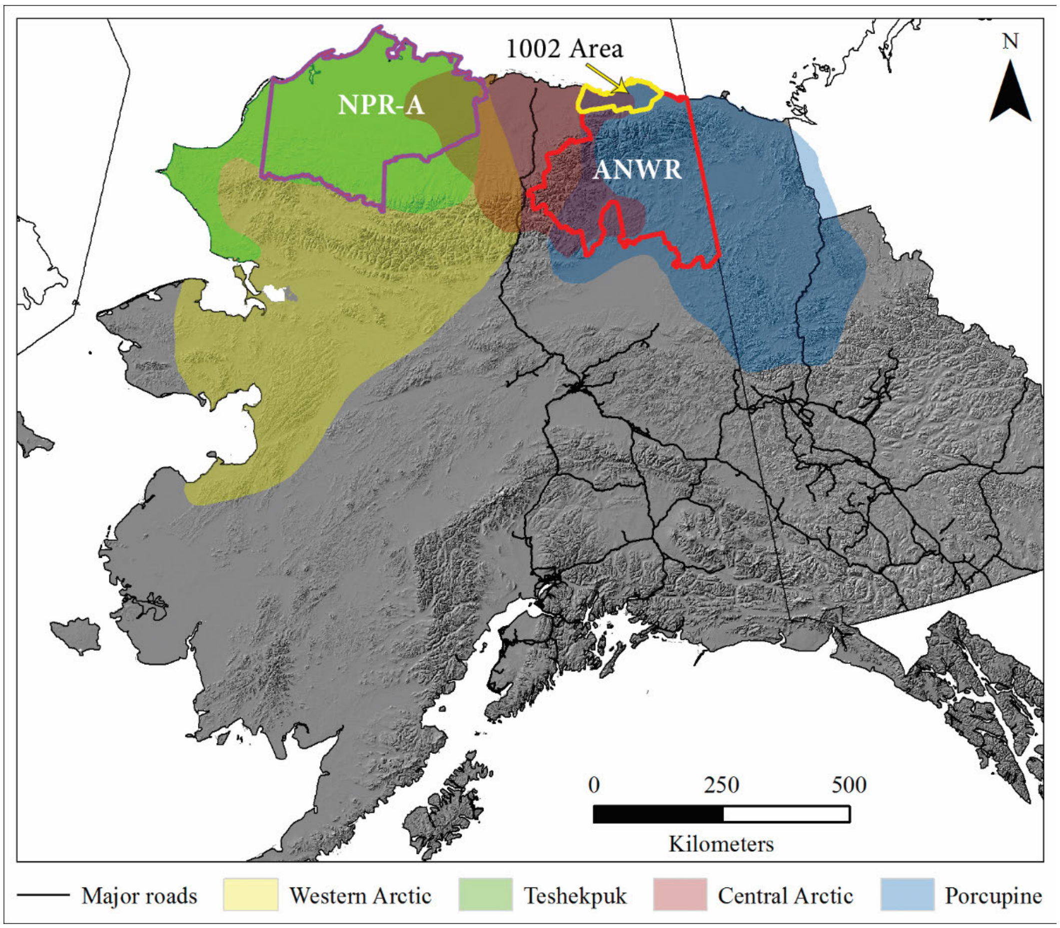

Figure 2. Map of approximate annual distributions of northern caribou herds in Alaska and Canada and approximate boundaries of the National Petroleum Reserve (NPR-A) and 1002 Area, Arctic National Wildlife Refuge (ANWR), Alaska.

According to Griffith and others (2002) and Harper and McCarthy (2015), much of the Porcupine Herd calved in the Arctic National Wildlife Refuge (often in the 1002 Area) during most years from 1983 to 2001, although some caribou calved in Canada in 1991 and calving areas shifted entirely into Canada in 2000 and 2001 (U.S. Fish and Wildlife Service, 2015a). Maps generated by the U.S. Fish and Wildlife Service (2015a) and McFarland and others (2017) show and discuss calving areas from 2002 to 2017. During these years, Porcupine caribou calving areas vary in location on the coastal plain of northeastern Alaska and northwestern Canada, with animals concentrated in Alaska in some years (2002–03, 2005, 2010, and 2016) and in Canada in others (2004, 2006–07, 2009, and 2011–13). Distribution maps show that caribou appeared to calve in both Alaska and Canada in 2008, 2014–15, and 2017 (U.S. Fish and Wildlife Service, 2015a; McFarland and others, 2017). During several of these years (for example, 2000 and 2001) the shift in calving distribution may have been a response to delayed snow melt on the coastal plain of Alaska (Arthur and Del Vecchio, 2017). The U.S. Fish and Wildlife Service (2015a) concludes that the annual variability in calving area indicates that the Porcupine Caribou Herd needs a large region from which the best conditions for calving can be selected in a given year. The Porcupine Caribou Herd uses the 1002 Area during the post-calving period, but little of this information is publicly available.

Miller and others (2013) determined the abundance of caribou bone and antler specimens of various ages to suggest patterns of caribou use of the coastal plain of the Arctic National Wildlife Refuge over many decades. These data corroborate observed changes in caribou distribution during the period of aerial monitoring (1983–2017).

Central Arctic Caribou Herd

Prior to 2001, the Central Arctic Caribou Herd spent little time in the 1002 Area and was included in Douglas and others (2002) only as an assessment of the possible effects of oil development on the Porcupine Caribou Herd. Since then, Nicholson and others (2016) published a paper on the annual movements of the herd from 2003 to 2007, and determined that portions of the 1002 Area were used by the Central Arctic Caribou Herd in some years (fig. 2).

The population size of the Central Arctic Caribou Herd increased from 1997 to 2008 at an average rate of approximately 10–13 percent per year before dropping from a high of 70,000 animals in 2010 to approximately 22,000 animals in 2016 (Taras and McFarland, 2016). The Alaska Department of Fish and Game reports that the two major contributing factors to the decline between 2013 and 2016 were high adult female mortality (approximately 50 percent of radio-collared caribou died) and animals switching herds (nearly 20 percent of radio-collared animals were found in either the Porcupine or Teshekpuk herds during the 3-year period; Taras and McFarland, 2016). The authors considered whether the population decline was influenced by range quality, the impact of oil infrastructure, calf production, adult sex ratio, predation, or disease. The authors discuss details for each of these factors and note that research continues into the possible role of these factors in population dynamics of the Central Arctic Caribou Herd. Also relevant to the Central Arctic Herd was a recent study by Gustine and others (2017) that determined that the quality (percent nitrogen) of summer forage for caribou on the coastal plain had not significantly changed between 1977 and 2011–2013 during peak parturition or lactation.

Currently (2017), oil and gas development occurs in the calving and summer ranges of the Central Arctic Caribou Herd and the adjacent Teshekpuk Caribou Herd, and has been proposed within the calving and summer range of the Porcupine Caribou Herd. Thus, there are persistent and emerging questions about the effects of indirect habitat loss, displacement of caribou from key calving grounds, and the ability of caribou to move between foraging areas and insect-relief habitat, and ultimately, the influence of these factors on caribou population dynamics (Nellemann and others, 2003). Given these questions, management agencies and energy companies need information about the behavioral effects of development on caribou, whether behavioral responses diminish over time as individuals habituate, and if those responses subsequently influence caribou demographic rates.

The above-ground footprint of oil development within Prudhoe Bay rapidly expanded in the late 1970s and 1980s, with modest increases during more recent years. Studies on the behavioral responses of Central Arctic Herd during the 1980s and early 1990s have indicated that densities of calving caribou declined near roads and as road density increased; calving areas shifted away from infrastructure; and movements between foraging and insect-relief areas were inhibited by roads and pipelines (Smith and Cameron, 1985; Cameron and others, 1992, 1995; Nellemann and Cameron, 1998). In subsequent studies, Pollard and others (1996) determined that caribou densities during the post-calving season (July and August) were approximately ten-fold greater in the vicinity of Prudhoe Bay when relative insect activity was moderate or high, and that some caribou used elevated roads and well pads for insect relief. Haskell and others (2006) speculated that among-year changes in the caribou distribution within 1 km of roads may have been due to partial habituation to infrastructure. All these studies were largely based on data from aerial or road surveys, where the limited frequency (for aerial surveys) and spatial distribution (for road surveys) of data collection potentially introduced bias (Joly and others, 2006). As a result, studies over broader spatial scales and longer time frames are needed to reliably identify important habitats near potential energy infrastructure (Wilson and others, 2012) and understand the cumulative effects of oil and gas development on caribou, including the possibility of habituation to infrastructure and other human disturbances (Johnson and Russell, 2014).

Arthur and Del Vecchio (2009) tested for differences in calf growth and survival between the less-developed eastern and more industrialized western calving ranges of the Central Arctic Herd (see fig. 1 of Arthur and Del Vecchio, 2009). From 2001 to 2007, the authors observed that birth mass and skeletal growth of calves was higher in less-developed areas, but that calf survival did not differ between the two areas. Although the power to detect changes in demographic rates was limited by sample size, the authors suggested their findings may be evidence that caribou using the less-developed eastern area were in better condition. However, the authors stated that because of other changes (density dependence, shifting distributions, and habitat conditions) that took place in the summer range during the period of oil development, differences between western and eastern areas do not necessarily imply effects of industrial activity, and that there is sufficient variability in habitat quality across the range of the Central Arctic Herd to affect calf size, which may in turn influence calf recruitment into the population.

Nicholson and others (2016) developed movement models of the Central Arctic Caribou Herd to estimate and quantify summer and winter ranges of adult females, to assess annual variation in these ranges, and to identify areas used during spring and fall migration. The authors determined considerable variation in range use during 4 years of monitoring and suggested that the high variability indicates that caribou may have altered their use of winter range based on inter-annual differences in winter weather, snow cover, forage characteristics, or other factors. The authors also found that caribou movements during 4 years of migration were too variable to enable use of a single model that could adequately describe movements of all individuals. Caribou migration routes used during this study varied among years, but some areas of concentrated use (“bottlenecks”) were used consistently by large numbers of caribou in all years. Nicholson and others (2016) suggested that these migration bottlenecks should be managed to provide for continued access by caribou.

Forage Quantity and Quality

Two recent studies examined changes in forage quantity and quality for ungulates and overall vegetation characteristics in the 1002 Area. First, Arthur and Del Vecchio (2013) examined fecal, soil, and vegetation samples collected during July 2009 to determine the role of forage quality in the decrease of muskoxen in northeastern Alaska. No differences were detected in mean concentrations of most mineral nutrients in soil and plant samples from sites used by muskoxen from 2007 to 2009 compared to sites that were used prior to 2006, but not in subsequent years. However, mineral concentrations of copper (Cu) in wideleaf polargrass (*Arctagrostis latifolia*) were well below minimum levels required for livestock and concentrations of zinc (Zn) in willow (*Salix alaxensis*) exceeded maximum levels recommended for livestock (Arthur and Del Vecchio, 2013).

Second, Jorgenson and others (2015a) summarized 25 years of vegetation plot data in the 1002 Area. This study monitored plant cover at 27 plots in 7 different years during 1984–2009 between the Katakturuk and Aichilik Rivers and quantified cover of all plant species and assessed change over time. Overall, the authors found that vegetation in the plots changed little in contrast to results from other studies in northern Alaska (see references in Jorgenson and others, 2015a). For the few plots with differences over time, the authors attributed the change to subsidence from thawing ground ice or floodplain dynamics. Jorgenson and others (2015a) remarked that the lack of an increasing trend in shrub cover in study plots was unexpected as this type of vegetation transition is occurring in many other parts of northern Alaska.

Predators

In Douglas and others (2002), the geographic distribution of golden eagle (*Aquila chrysaetos*) nest sites, wolves (*Canis lupus*), and brown bears (*Ursus arctos*) within and adjacent to the 1002 Area were surveyed and mapped. Eagle and wolf distributions were based on aerial surveys and brown bear distributions were based on annual locations of radio-collared bears during the first week of June from 1983 to 1994. There has been no update of this information for the 1002 Area since 2002.

Muskoxen

The population of muskoxen in northeastern Alaska (Colville River east to the Canadian border) declined from a peak of 700 animals in 1995 to approximately 216 in 2006 (Arthur and Del Vecchio, 2013; Afema and others, 2017). Within just the coastal plain of the Arctic National Wildlife Refuge, muskoxen virtually disappeared by 2006 between the Canning River and the Canadian border (Arthur and Del Vecchio, 2017). The population decline was less severe (35 percent) between the Colville River and the Canning River. According to Afema and others (2017) there are no known observed climatic, anthropogenic, or other environmental influences that provide a plausible explanation for the observed population decline of muskoxen in northeastern Alaska. Arthur and Del Vecchio (2017) state that the availability of moose and caribou calves as prey for brown bears was greatly reduced because of a moose population decline in the mid-1990s and a shift in the calving distribution of the Porcupine Caribou Herd to areas farther east in northern Canada during 2000 and 2001. Thus, Arthur and Del Vecchio (2017) suggest that reduced availability of other prey species may have caused some bears to focus predation on muskoxen, thus potentially contributing to the muskox population decline. Although predation by brown bears was the most common cause of death for muskox calves, the population decline was likely caused by a combination of factors acting in combination with predation, including disease, poor nutrition, low calf productivity and recruitment as well as poor survival of adults (Arthur and Del Vecchio, 2017).

Afema and others (2017) found evidence for multiple diseases that potentially contributed to the mortality of muskoxen. Afema and others (2017) concluded that the northeastern muskox population was adversely affected by complex nutritional and infectious disease dynamics resulting in comorbidity that also likely increased susceptibility to predation. Analysis of fecal, soil, and vegetation samples collected between 2007 and 2011 by Arthur and Del Vecchio (2013) indicate that grasses and sedges were the most common forage types for both coastal and more inland muskox groups. There was some evidence of differences in diet between coastal and inland groups, but sample sizes were insufficient for meaningful statistical comparisons.

Polar Bears

Polar bears of the Southern Beaufort Sea subpopulation historically spent the entire year on the sea ice, with the exception of a relatively small proportion of adult females that would come ashore during autumn and enter maternity dens. However, over the last two decades, the southern Beaufort Sea has experienced a marked decline in summer sea ice extent, along with a pronounced lengthening of the melt season (period of time between sea ice break-up and freeze-up; Stroeve and others, 2014; Stern and Laidre, 2016). The dramatic changes in the extent and phenology of sea ice habitat during summer and prior to denning have coincided with evidence suggesting that use of terrestrial habitat has increased, including in the Arctic National Wildlife Refuge 1002 Area.

Schliebe and others (2008) determined that an average of 4 percent of the Southern Beaufort Sea subpopulation of polar bears was on land in a given autumn during 2000–2005, and that the percentage increased when sea ice was farther from the coast. More recently, Atwood and others (2016) determined that the percentage of radio-collared adult females coming ashore in summer and fall increased from 5.8 to 20 percent between 2000 and 2014. Over the same period, the mean duration of the open-water season (the period when <15 percent of the continental shelf is covered by ≥15 percent concentration sea ice) increased by 36 days and the mean length of stay on land by polar bears increased by 31 days (Atwood and others, 2016). While on shore, the distribution of polar bears is largely influenced by the opportunity to feed on the remains of subsistence-harvested bowhead whales aggregated at 3 sites along the coast, including adjacent to the community of Kaktovik (Rogers and others, 2015; McKinney and others, 2017; Wilson and others, 2017) (fig. 3).

In addition to using land as refugia during the open-water season, Southern Beaufort Sea polar bears have increasingly used land for maternal denning. Olson and others (2017) examined the choice of denning substrate (land compared to sea ice) by adult females between 1985 and 2013 and determined that the frequency of land-based denning increased over time, constituting 34.4 percent of all dens from 1985 to 1995, 54.6 percent from 1996 to 2006, and 55.2 percent from 2007 to 2013. Additionally, the frequency of land denning was directly related to the distance that sea ice retreated from the coast. From 1985–1995 and 2007–2013, the average distance from the coast to 50 percent sea ice concentration in September (when sea ice extent reaches its annual minimum) increased 351±55 km, while the distance to 15 percent sea ice concentration increased by 275±54 km. Rode and others (2018) determined that reproductive success was greater for females occupying land-based dens compared to ice-based dens, which may be an additional factor contributing to the increase in land-based denning. Land-based dens are mostly distributed along the central and eastern coast of Alaska's Beaufort Sea, which includes the 1002 Area (Durner and others, 2010; fig. 4). Durner and others (2006) estimate there is approximately 3,020 linear kilometers of suitable denning habitat within the 1002 Area (fig. 5).

Collectively, these results suggest that the use of land by polar bears as summer refugia and for denning in winter will likely continue to increase with additional loss of sea ice. Although the effects that increased land use may have on nutrition, energetics, and reproduction are not fully understood, it is worth noting that the Southern Beaufort Sea subpopulation of polar bears has experienced a recent decline in abundance (Bromaghin and others, 2015). Increased frequency of bears on land, coupled with expanding human activities, is expected to lead to greater human-polar bear interaction and conflict (Atwood and others, 2016). The increased numbers of bears on land in the vicinity of Kaktovik has also led to a dramatic increase in popularity of commercially guided polar bear viewing. This industry was virtually non-existent in Kaktovik before 2006, but through 2016 more than 2,300 viewer-trips were recorded during the 61-day commercial viewing season (some viewers may have participated in multiple trips; Reed and Duplisea, 2017). This use greatly exceeds the total use by all other recreational activities in the Arctic National Wildlife Refuge.

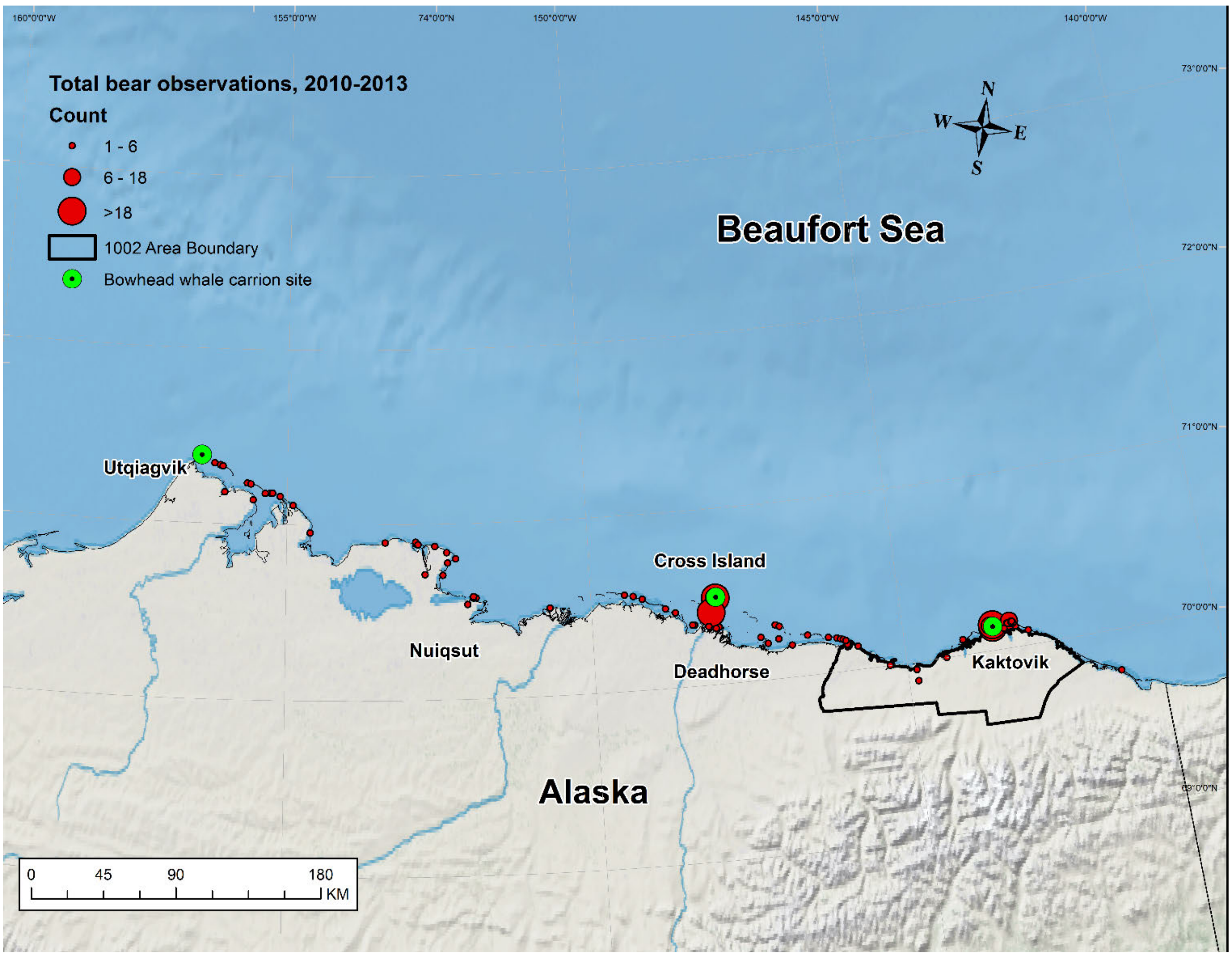

Figure 3. Map showing distribution of polar bears observed from 2010 to 2013 during autumn aerial surveys along the north coast, Alaska. The black line shows the approximate boundary of the 1002 Area, Arctic National Wildlife Refuge. (Adapted from Atwood and others, 2016).

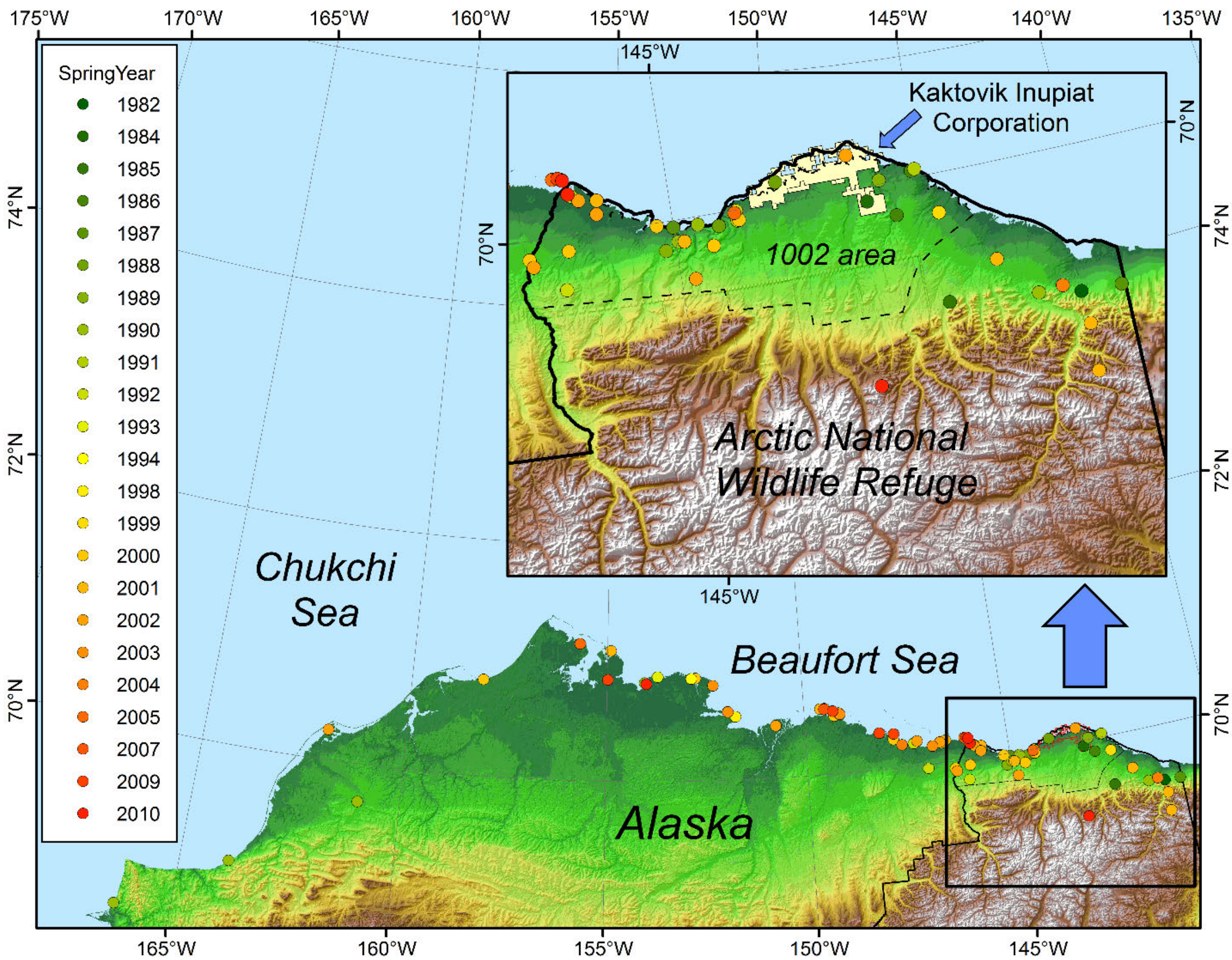

Figure 4. Map showing polar bear maternal dens on land or fast ice discovered with very high frequency (VHF) or satellite telemetry along north coast, Alaska, 1982–2010. Polar bears den during winter and "Spring Year" denotes the year the den was exited. The dashed line shows the approximate boundary of the 1002 Area, Arctic National Wildlife Refuge, Alaska.

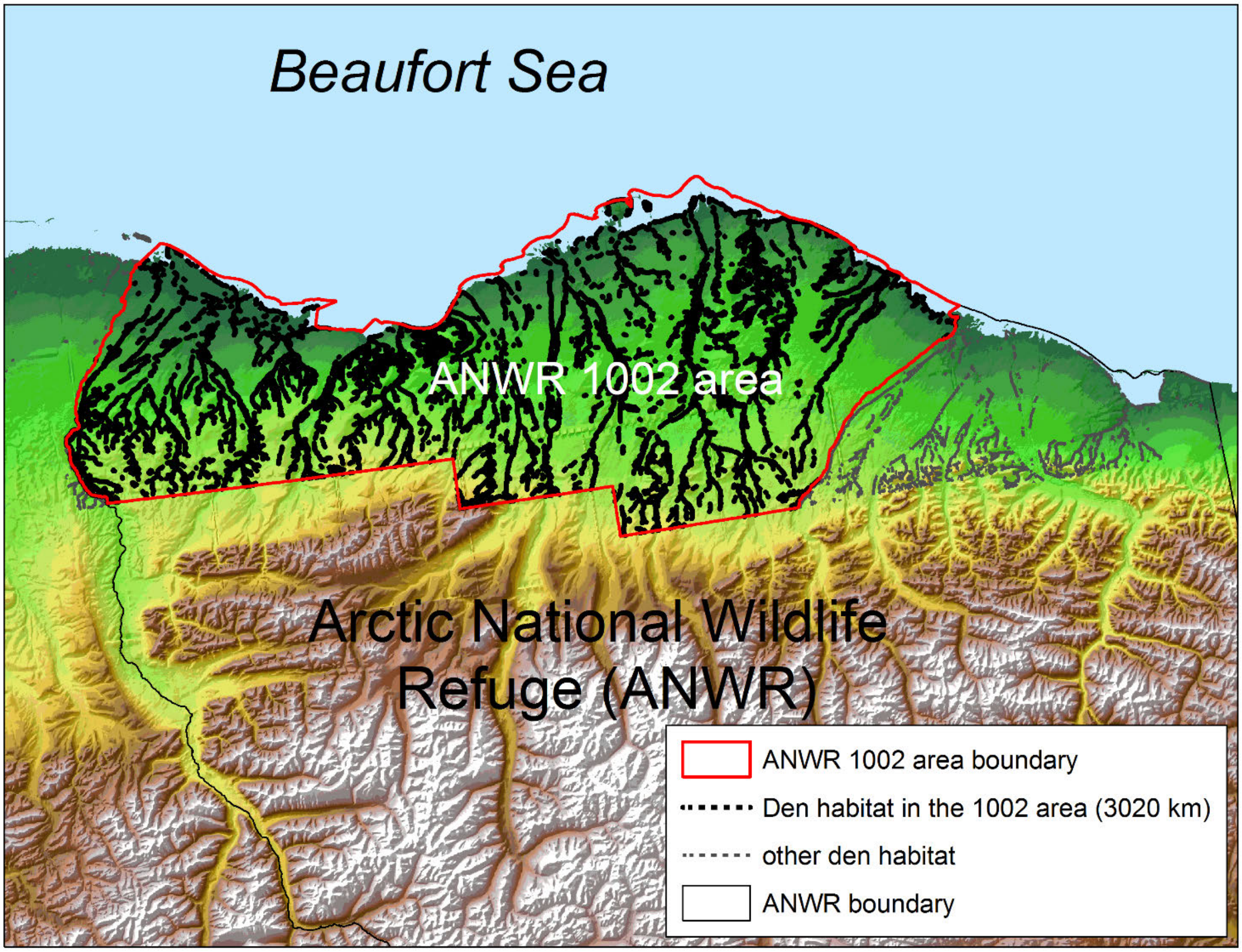

Figure 5. Map showing estimate of suitable polar bear maternal denning habitat within the approximate boundary of the 1002 Area, Arctic National Wildlife Refuge, Alaska. (Based on Durner and others, 2006).

Snow Geese

Snow geese are one of the most abundant bird species in the 1002 Area, but use is mostly for autumn staging after the breeding season. The Arctic National Wildlife Refuge is part of a larger staging area that extends east from the U.S. and Canadian border for approximately 500 km along the Arctic Coastal Plain to the Bathurst Peninsula of Canada. Snow geese that use the coastal staging area mainly originate from nesting areas on Banks Island in Canada. That population has increased to about 500,000 breeding individuals from the 200,000 birds present in the early 1990s (Pacific Flyway Council, 2013). Elsewhere on the Arctic Coastal Plain of Alaska, the number of breeding snow geese is rapidly increasing (Burgess and others, 2017; Hupp and others, 2017). Burgess and others (2017) suggest that some of the increase in Alaska may be due to immigration of snow geese from expanding breeding populations in the Canadian Arctic.

Since 1986, the U.S. Fish and Wildlife Service Migratory Bird Management Office has conducted annual aerial surveys of the Arctic Coastal Plain to generate indices of nesting waterbird population size and trends over time (Stehn and others, 2013). The 1002 Area is within the low bird density strata with transects that are widely spaced resulting in low power to detect clumped distributions of birds, such as snow geese that nest in colonies. There is uncertainty regarding current population status of snow geese staging within the 1002 Area. Maximum counts of autumn staging snow geese made in most years between 1973 and 2004 through a variety of survey methods are summarized by the U.S. Fish and Wildlife Service (2015a). In 2004, the last survey for which data are available, a total of 189,636 birds was observed on the coastal plain. Given the overall increase in numbers of snow geese in Arctic Alaska and Canada, further increases in the use of autumn staging areas in the 1002 Area should be expected.

Additional Wildlife and Habitat Research

Migratory Birds

The U.S. Fish and Wildlife Service (2015b) lists a total of 201 migratory bird species for the entirety of the Arctic National Wildlife Refuge. The 201 species total is a cumulative number, generated over many years of observations and includes species that were only seen once and those seen frequently each year across the refuge. At least 57 species regularly occur as breeding, nonbreeding, or both in the 1002 Area (table 1). These are species recorded on the coastal plain or nearshore areas of the Beaufort Sea as “fairly common”, “common”, or “abundant”.

Table 1. List of 57 fairly common, common, and abundant breeding and nonbreeding bird species for the coast, inland, and barrier island and lagoon regions of the 1002 Area of the Arctic National Wildlife Refuge, Alaska.

[**Species**: Species names and order follows Chesser and others (2017). **Reference**: Source references used are: 1, Garner and Reynolds (1986); 2, Garner and Reynolds (1987); 3, Brown and others (2007); 4, Dau and Bollinger (2009); 5, U.S. Fish and Wildlife Service (2015b); 6, Kendall (2005). Generalized categories of abundance were used by most references since few quantitative surveys have been conducted in the 1002 Area. For Dau and Bollinger (2009), we did not include species with less than or equal to 15 average sightings per year (see table 2). In cases where habitat area is given as "coastal plain" by a reference, both coast and inland areas are included. Abbreviations: B, breeding, NB, non-breeding]

Species	Region within 1002 Area			Reference
	Coast	Inland	Barrier Islands and Lagoons	
Greater white-fronted goose (*Anser albifrons*)	NB	NB		1, 2, 5
Snow goose (*Anser caerulescens*)	NB	NB		1, 2, 5
Brant (*Branta bernicla*)	B, NB		NB	1, 2, 4
Cackling goose (*Branta hutchinsii*)	B, NB	B, NB		1, 2, 5
Tundra swan (*Cygnus columbianus*)	B, NB	B, NB		1, 2, 5, 6
American wigeon (*Mareca americana*)	NB			1
Northern pintail (*Anas acuta*)	B, NB	B, NB	NB	1, 2, 4, 5
Greater scaup (*Aythya marila*)	NB		NB	1, 4
King eider (*Somateria spectabilis*)	B, NB		NB	2, 4, 5
Common eider (*Somateria mollissima*)	NB		B, NB	1, 2, 4, 5, 6
Surf scoter (*Melanitta perspicillata*)			NB	1, 4
White-winged scoter (*Melanitta fusca*)	NB		NB	4, 5, 6
Long-tailed duck (*Clangula hyemalis*)	B, NB	B	NB	1, 2, 4, 5, 6
Red-breasted merganser (*Mergus serrator*)	NB	B	NB	1, 2, 4, 5, 6
Willow ptarmigan (*Lagopus lagopus*)	B, NB	B, NB		1, 2, 5
Rock ptarmigan (*Lagopus muta*)	B, NB	B, NB		1, 2, 5
Sandhill crane (*Antigone canadensis*)	NB			2
Black-bellied plover (*Pluvialis squatarola*)	NB			1, 2, 5
American golden-plover (*Pluvialis dominica*)	B, NB	B, NB		1, 2, 3, 5
Semipalmated plover (*Charadrius semipalmatus*)		B, NB		2, 5
Upland sandpiper (*Bartramia longicauda*)		B		5
Whimbrel (*Numenius phaeopus*)		NB		2
Ruddy turnstone (*Arenaria interpres*)	B, NB	B, NB		1, 2, 5
Stilt sandpiper (*Calidris himantopus*)	B, NB	B		1, 2
Sanderling (*Calidris alba*)	NB			2
Dunlin (*Calidris alpina*)	B, NB	B		1, 2, 3
Baird's sandpiper (*Calidris bairdii*)	B	NB		1, 2
Buff-breasted sandpiper (*Calidris subruficollis*)	B	B		1, 2
Pectoral sandpiper (*Calidris melanotos*)	B, NB	B, NB		1, 2, 3, 5, 6
Semipalmated sandpiper (*Calidris pusilla*)	B, NB	B, NB		1, 2, 3, 5
Western sandpiper (*Calidris mauri*)	NB			1, 2
Long-billed dowitcher (*Limnodromus scolopaceus*)	B, NB	B, NB		1, 2, 5
Red-necked phalarope (*Phalaropus lobatus*)	B, NB	B		1, 2, 3, 5
Red phalarope (*Phalaropus fulicarius*)	B, NB	B, NB		1, 2, 3, 5
Pomarine jaeger (*Stercorarius pomarinus*)	B, NB	B, NB		1, 2, 5

Species	Region within 1002 Area			Reference
	Coast	Inland	Barrier Islands and Lagoons	
Parasitic jaeger (*Stercorarius parasiticus*)	NB	NB		1, 2, 5
Long-tailed jaeger (*Stercorarius longicaudus*)	B, NB	B, NB		1, 2, 5
Glaucous gull (*Larus hyperboreus*)	B, NB	NB	B, NB	1, 2, 4, 5, 6
Arctic tern (*Sterna paradisaea*)	NB	NB	B	1, 2, 5, 6
Red-throated loon (*Gavia stellata*)	B, NB		NB	1, 2, 4, 5, 6
Pacific loon (*Gavia pacifica*)	B, NB	B, NB	NB	1, 2, 4, 5, 6
Yellow-billed loon (*Gavia adamsii*)	NB		NB	2
Rough-legged hawk (*Buteo lagopus*)	NB	NB		2
Golden eagle (*Aquila chrysaetos*)	NB	NB		1, 2, 5
Snowy owl (*Bubo scandiacus*)	B, NB	B, NB		1, 2, 5
Short-eared owl (*Asio flammeus*)	B	B		1, 2, 5
Peregrine falcon (*Falco peregrinus*)	NB			2
Common raven (*Corvus corax*)		NB		2
Eastern yellow wagtail (*Motacilla tschutschensis*)	B	B, NB		1, 2, 5
Common redpoll[1] (*Acanthis flammea*)	B	B		1, 2, 5
Hoary redpoll[1] (*Acanthis hornemanni*)	B	B		1, 2, 5
Lapland longspur (*Calcarius lapponicus*)	B	B		1, 2, 5
Snow bunting (*Plectrophenax nivalis*)	B	B	B, NB	5, 6
American tree sparrow (*Spizelloides arborea*)		B		1, 2, 5
Savannah sparrow (*Passerculus sandwichensis*)	B	B		1, 2, 5
White-crowned sparrow (*Zonotrichia leucophrys*)		B		1

[1]Redpoll species were not differentiated in Garner and Reynolds (1986, 1987), but are split into two species here.

The only bird species listed under the provisions of the Endangered Species Act of 1973 that are known to occur in the 1002 Area are the threatened Alaska-breeding population of the Steller's eider (*Polysticta stelleri*) and threatened spectacled eider (*Somateria fischeri*). These species have populations in northern Alaska that range from 576 birds (292–859: 90-percent confidence interval [CI]) for the Steller's eider (Stehn and Platte, 2009) to an average index of 7,158 total birds (6,536–7,781: 90-percent CI) for spectacled eiders (Stehn and others, 2013). Steller's eiders are concentrated in the western portion of the Arctic Coastal Plain near Utqiaġvik (formerly Barrow); whereas spectacled eiders are more widely distributed across the Arctic Coastal Plain. The Steller's eider is listed as a "rare visitor" and is not known to breed in the 1002 Area. However, the spectacled eider is listed as a "rare breeder" on the coastal plain of the Arctic National Wildlife Refuge (U.S. Fish and Wildlife Service, 2015), but it is not known how many nests occur annually within the 1002 Area.

Since 1986, the U.S. Fish and Wildlife Service has conducted annual aerial surveys of much of the Arctic Coastal Plain of northern Alaska to generate indices of nesting waterbird population size and trends over time (Stehn and others, 2013). However, only about one-third of the 1002 Area is currently surveyed, and what is surveyed falls within the low-density strata. Surveys within the low-density strata have far fewer transects that are farther apart and thus have little power to detect and determine trends of breeding and non-breeding migratory birds.

Bart and others (2013) used aerial and ground survey data to estimate distribution, abundance, and density of 3 groups of aquatic birds (waterfowl, loons, and grebes; shorebirds; and gulls, terns, and jaegers) across much of the Arctic Coastal Plain. They reported a west-to-east gradient of abundance and density of these 3 groups, with higher numbers in the west (National Petroleum Reserve - Alaska [NPR-A]), intermediate numbers in the central coastal plain (Prudhoe Bay), and lower numbers in the east (Arctic National Wildlife Refuge).

Kendall (2005) searched the barrier islands of the 1002 Area on foot in the summers of 2003–2004 and documented a total of 229 common eider nests. From 1999 to 2009, during late June and early July, Dau and Bollinger (2009) conducted aerial surveys in nearshore waters and along barrier islands of the Arctic Coastal Plain, including areas within the 1002 Area, to count common eiders (*Somateria mollissima*) and other waterbirds. A summary of average numbers of the most common waterbirds counted during these aerial surveys that occurred within the 1002 Area (survey segments 22–27) is presented in table 2. Additionally, Lysne and others (2004) conducted near-shore sea duck and loon aerial surveys in late July and early August of 2002 and 2003 along the coast of the Arctic National Wildlife Refuge. The authors documented similar species to Dau and Bollinger (2009), but observed thousands more long-tailed ducks (*Clangula hyemalis*) during the surveys.

Table 2. Average number per year of the 17 most common bird species observed from 1999 to 2009 on coastal lagoon and barrier island aerial surveys within the 1002 Area of the Arctic National Wildlife Refuge, Alaska.

[From U.S. Fish and Wildlife Service (Dau and Bollinger, 2009). **Species:** Species names and order follows Chesser and others (2017)]

Species	Average number
Brant (*Branta bernicla*)	45
Cackling goose (*Branta hutchinsii*)	12
Tundra swan (*Cygnus columbianus*)	7
Northern pintail (*Anas acuta*)	44
Greater scaup (*Aythya marila*)	179
King eider (*Somateria spectabilis*)	184
Common eider (*Somateria mollissima*)	593
Surf scoter (*Melanitta perspicillata*)	2,173
White-winged scoter (*Melanitta fusca*)	271
Long-tailed duck (*Clangula hyemalis*)	819
Red-breasted merganser (*Mergus serrator*)	306
Glaucous gull (*Larus hyperboreus*)	553
Arctic tern (*Sterna paradisaea*)	5
Red-throated loon (*Gavia stellata*)	15
Pacific loon (*Gavia pacifica*)	38
Yellow-billed loon (*Gavia adamsii*)	4

Shorebirds

The Arctic Coastal Plain of Alaska is an important region for millions of migrating and nesting shorebirds. Brown and others (2007) conducted surveys of breeding shorebirds during June of 2002 and 2004. They encountered 14 shorebird species and estimated that 230,000 (95-percent CI: 104,000–363,000) shorebirds occupied the 1002 Area during the breeding season. Species richness and density were typically highest in wetland or riparian habitats and deltas (such as near the Canning River Delta). Johnson and others (2007) determined that shorebird species were more abundant in the coastal ecoregion (that is, closer to the coast rather than farther inland) and that across the entire Arctic Coastal Plain, species richness was highest in the western part of the Beaufort coastal plain. However, several species were more abundant in the east, reflecting longitudinal diversity. Johnson and others (2007) concluded that the distribution maps of their study would be helpful for documenting large-scale shifts in species ranges, but that more detailed habitat-based maps would be needed to document subtle changes in distribution.

Saalfeld and others (2013a) developed habitat suitability models for eight species of shorebirds across the Arctic Coastal Plain. Like Johnson and others (2007), they determined that the most suitable habitat was in the NPR-A, followed by the Arctic National Wildlife Refuge. The authors also noted that because habitat suitability maps depict areas with minimum habitat requirements for a given species, ground surveys should be conducted prior to establishing final recommendations for any future development to verify the use of an area by nesting shorebirds.

Taylor and others (2010) used aerial surveys of the entire northern coast of Alaska during summers of 2005–07 to locate concentrations of staging shorebirds and determine species richness and composition, seasonal phenology, and habitat selection. The authors noted large concentrations of staging shorebirds on the Sagavanirktok and Kongakut river deltas. A comparison to data collected in the mid-1970s indicated that foraging habitat types used by staging shorebirds were largely unchanged through time. Taylor and others (2011) subsequently used radio transmitters on shorebirds to determine species movements and residence times on the Arctic Coastal Plain following the breeding season. Results demonstrated how different species use the northern Alaska coast and suggest that individuals use multiple post-breeding sites as they migrate eastward before ultimately moving south down the Central Flyway. Brown and others (2012) used a transect survey of Arctic National Wildlife Refuge river deltas, and determined that most of the deltas were used by large numbers of shorebirds during fall migration with the Jago River Delta being one of the highest use areas.

Churchwell and others (2016, 2017) examined the diversity and annual variation of benthic invertebrate communities within the Canning, Okpilak, Hulahula, and Jago river deltas in the coastal part of the 1002 Area. Churchwell and others (2016) found both freshwater and marine organisms were present and that species diversity was relatively low in comparison to river deltas at more southerly latitudes. The benthic resources provide food for large numbers of migratory shorebirds during the summer open-water period. Semipalmated sandpipers (*Calidris pusilla*) used the Jago River Delta in large numbers early in the migration (around August 1) and the Okpilak/Hulahula River Delta later in migration (around August 13; Churchwell and others, 2017). Based on analyses of stable isotopes in their diet, shorebirds fed on benthic invertebrates that were patchily abundant, but preferred prey were not always the most abundant invertebrate species present on a given delta (Churchwell and others, 2017). Accordingly, different invertebrate species were the apparent preferred prey at each delta.

Disturbance to Birds from Industry and Investigators

A number of recent studies have examined direct and indirect effects of industrial activities to birds on the Arctic Coastal Plain. Saalfeld and others (2013b) examined productivity of nesting shorebird species in relation to the development of a landfill near Utqiaġvik and found that nest densities, nest survival, and return rates were generally greater inside than outside a fenced area surrounding the landfill. Bart and others (2013) examined aerial survey data within the Prudhoe Bay oil fields and maps of numbers recorded did not reveal any evidence that density of birds was lower near developed areas. The USGS studied waterfowl using the lagoons in the vicinity of Prudhoe Bay (considered an industrial area) and in an undisturbed reference area adjacent to the Arctic National Wildlife Refuge (Flint and others, 2003; Lacroix and others, 2003; Flint and others, 2016). Those studies indicated that although flocks responded strongly to disturbance stimuli, there was no clear effect of open water seismic industrial activity and other disturbance on habitat use or foraging behaviors by molting long-tailed ducks (*Clangula hyemalis*). The study also indicated there was no effect of industrial development on nesting common eiders (*Somateria mollissima*) with the possible exception of increased nest predation risk for common eiders nesting near oil fields.

Liebezeit and others (2009) quantified nest survival of shorebird and passerine species in relation to areas with and without industrial development across the Arctic Coastal Plain. The authors also investigated the abundance and effect of subsidized predators (those benefiting from an association with human development) and non-subsidized predators on the nesting success of prey species. The authors observed substantial natural variation in annual nest survival across years and study locations, leading the authors to conclude that a development effect, if present, may be small relative to the natural annual variability in the Arctic. The authors found no effect of industry on nesting success for shorebirds (the most abundant guild of nesting birds on the Arctic Coastal Plain), but did observe a decline in nest survival of passerine species (the second most abundant group of birds nesting on the Arctic Coastal Plain) within 5 km of infrastructure. Although predation events were determined to be the primary cause of nest failure, the authors found that predator abundance was not related to nest survival and non-subsidized predators accounted for 32–77 percent of the total predators observed during surveys.

Meixell and Flint (2017) also examined predators and distance to industrial disturbance in relation to nesting behavior and success of greater white-fronted geese (*Anser albifrons*). Additionally, these authors quantified the effect of observer visits to nests. This study indicated only minor effects of industrial activity on goose nest attendance patterns and no measurable impact of low-flying helicopters on nest attendance patterns of geese. Nest survival was low for greater white-fronted geese nesting closer to industrial activity, but only in the first of the 2-year study when the number of arctic fox (*Vulpes lagopus*) visits to nests and fox depredation events were higher. This was likely because foxes used buildings as a base from which to hunt nesting birds and their eggs. In a year with lower fox activity, there was no difference in nest survival for nests close to and farther from industrial activity. Human foot traffic directly approaching nests had the greatest impact to nest attendance patterns and nest survival of greater white-fronted geese. Results for observer effects are consistent with findings from other studies on the central Arctic Coastal Plain involving king eiders (*Somateria spectabilis*; Bentzen and others, 2008) and loons (Uher-Koch and others, 2015). Meixell and Flint (2017) conclude that these results demonstrate a differential response by nesting geese to varying types of disturbance. Whereas observer visits were associated with direct human encroachment at nests that caused female geese to be absent from nests longer, sources of industrial disturbance in their study were characterized primarily by vehicular, aircraft, and foot travel that followed similar routes and usually did not directly approach nest sites.

Bentzen and others (2017) used real and artificial shorebird and waterfowl nests located along roads in industrial areas of the central Arctic Coastal Plain to evaluate the relationship between distance from infrastructure and bird nesting success. The study indicated no effect from infrastructure on nest survival in either real or artificial nests. However, only 18 percent of artificial shorebird nests and 4 percent of artificial waterfowl nests survived the entire study. Since these rates appear to be biased low relative to real nests, the authors caution about conclusions derived from artificial nests regarding development impacts and nest predators.

Permafrost

Permafrost in the Beaufort Sea coastal area, including the 1002 Area, is continuous and active layer depth varies depending upon local conditions (Kanevskiy and others, 2013). Based on long-term (1977–2003) permafrost measurements, Osterkamp (2005) reported that the magnitude of total warming at the surface of the permafrost was 3–4 °C for the Arctic Coastal Plain. Kanevskiy and others (2013) surveyed permafrost characteristics across the Arctic Coastal Plain, including 16 sites within the 1002 Area. They identified four main land forms within the 1002 Area including (1) the primary surface, composed of predominantly gravelly sand, (2) the Yedoma, defined as extremely ice-rich Pleistocene permafrost with eolian silt, (3) river deltas and tidal flats, and (4) eolian dunes of sand. All of these land forms had high levels of volumetric ice (>73 percent except for eolian sand which had 43 percent ice). The high ice content implies that these areas may be susceptible to subsidence associated with permafrost degradation. In areas of the NPR-A, Tape and others (2013) identified dramatic changes in vegetation characteristics apparently resulting from permafrost subsidence. As such, broad sections of the 1002 Area may see future changes in vegetation composition associated with permafrost degradation.

Jorgenson and others (2015a) found high variability and no significant trend in depth of the soil active layer above permafrost at their vegetation monitoring plots. Jorgenson and others (2015b) compiled a permafrost database to merge information on soil stratigraphy and laboratory data for 861 sites with boreholes, pits, and exposures where permafrost can be examined and monitored.

Farquharson and others (2016) examined the spatial distribution of thermokarst terrain in the western section of the Arctic Coastal Plain to determine which landscapes are most susceptible to thaw in the near future. The study determined that the coastal marine silts may be particularly susceptible to thaw, which has implications for ecosystem processes and human infrastructure near Utqiaġvik and in the NPR-A. Similar information has not been developed for northeastern Alaska. Permafrost temperatures from deep boreholes spread across the western Arctic Coastal Plain indicate a trend of warming in the near surface, likely as a result of warmer winters with more snowfall and warmer summers (Clow, 2014). Borehole measurements on the coastal plain of the Arctic National Wildlife Refuge showed that permafrost temperatures increased between 1985 and 2004, at a similar rate to other North Slope sites (Osterkamp and Jorgenson, 2006).

Coastal Erosion

With the recent declines in sea ice in the Beaufort Sea, coastal erosion has become widespread and may be accelerating along the Arctic coast of Alaska, and is transforming some coastal habitats. Gibbs and Richmond (2015, 2017) examined shoreline change along Alaska's Arctic coast between 1947 and 2012 and found coastal erosion to be widespread and a threat to defense and energy-related infrastructure, coastal habitats, and Alaska Native communities. Gibbs and Richmond (2015, 2017) applied standard, repeatable methods for mapping and analyzing shoreline change so that periodic, systematic, and internally consistent updates regarding coastal erosion and land loss can be made nationally. Gibbs and Richmond (2017) determined that the northern coast of Alaska is dominantly erosional, with 84 percent of the total transects showing shoreline retreat over the long term (1940s–

2010s) and 77 percent in the short term (1980s–2010s). The greatest average erosional rates were measured between Cape Halkett and the Ikpikpuk River Delta within the NPR-A. The greatest average erosional rates for regions in the 1002 Area (Canadian border to Hulahula River and Hulahula River to Staines River) were lower (approximately -0.9 m/yr) than for areas in the NPR-A. According to Gibbs and Richmond (2015), observed and projected increases in periods of sea-ice free conditions suggest that Arctic coasts will be more vulnerable to storm surge and wave energy, potentially resulting in accelerated shoreline erosion and terrestrial habitat loss in the future.

Coastal Lagoons

Coastal lagoons of the southern Beaufort Sea support large numbers of fish and millions of migratory birds in the summer months. Dunton and others (2012) demonstrated a significant terrestrial carbon subsidy to the coastal lagoon ecosystem of the southern Beaufort Sea in northeastern Alaska. The authors found evidence for substantial energy transfer from terrestrial sources of carbon to zooplankton and benthic communities that in turn support higher trophic level organisms, such as waterfowl and fish, including Arctic cod. In 2017, a 5-year study began at a new Long-Term Ecological Research (LTER) site in northeastern Alaska along the Beaufort Sea coast that will focus on the ecological interactions between land and ocean in this region.

Fish

Arctic cisco (*Coregonus autumnalis*) and Dolly Varden (*Salvelinus malma*) are common fish species in coastal regions of northern Alaska. Freshwater habitats used by these and other fish species in the 1002 Area have been considered as potential water sources for future oil and gas development (Brown and others, 2014, and references therein). Brown (2008) quantified the long-term trends in demographic composition, relative abundance, and body condition of Arctic cisco and Dolly Varden in coastal lagoon systems of the 1002 Area near Barter Island during the years 1988–1991 and 2003–2005. Brown (2008) determined that abundance of mature-size Arctic cisco remained relatively stable between the early and late years of the study and that cisco encountered in the Barter Island region come from overwintering habitats in both the Colville and Mackenzie River deltas. Relative abundance of Dolly Varden remained stable across the study period. Additional information regarding other fish species is also discussed. Vivant (2009) provides aerial index counts of overwintering Dolly Varden from the Canning and Hulahula Rivers in 2007 and 2008. Counts varied substantially between years. For the Canning River, 3,936 and 7,533 fish were counted on the Canning River in 2007 and 2008, respectively. On the Hulahula River, 9,575 and 3,653 fish were seen in 2007 and 2008, respectively. Vivant cautions that these numbers should not be used to infer trends in abundance because of differences in survey methods, timing of fish migration, and annual variation.

Brown and others (2014) examined overwintering locations for Dolly Varden in perennial springs in rivers of the 1002 Area. Using radio transmitters, Brown and others (2014) found four discrete areas with perennial springs for overwintering Dolly Varden along the Hulahula River, with one of these occurring within the coastal plain of the 1002 Area. These four areas appear to represent all overwintering habitat in the Hulahula River drainage. Additionally, Brown and others (2014) determined that 20 percent of tagged fish moved to sites within the Canning, Aichilik, and Kongakut River drainages in subsequent years for overwintering.

The U.S. Fish and Wildlife Service (2015) describes some of the 42 fish species found within the Arctic National Wildlife Refuge, not all of which occur in the 1002 Area. Thorsteinson and Love (2016) describe geographic distributions, life cycle schematics, and ecological information for 109 marine fish species of the Chukchi and Beaufort seas, including coastal and offshore regions of the 1002 Area. An on-going USGS research project is examining fish community composition in comparison to historical sampling in the 1980s and 1990s in the Beaufort Sea, including the coastal lagoons of the 1002 Area.

Water Resources

Understanding water resources in the 1002 Area informs questions related to multiple ecosystem components as well as possible infrastructure development. A USGS streamgage station was established October 1, 2010, on the Hulahula River (69°42'41"N., 144°11'24"W.) along a reach draining a 684 mi^2 watershed comprised of mountain, foothill, and coastal plain ecoregions. Air temperature, precipitation, and water levels are recorded and discharge is computed from a stage-discharge relationship. This is one of only five streamgages north of the Brooks Range, the only station within the Arctic National Wildlife Refuge, and the only site in the U.S. Arctic that measures streamflow from a glaciated watershed. More information is available at: https://waterdata.usgs.gov/ak/nwis/inventory/?site_no=15980000. Two additional USGS streamgages operated in the past. The Canning River station (69°52'55"N., 146°23'09"W.) operated from June 23, 2008, to September 29, 2012, and was located 338 ft above mean sea level along a reach draining 1,930 mi^2 of the Brooks Range and foothills. The Tamayariak River station (69°51'55"N., 145°35'34"W.) operated from June 1, 2008, to September 29, 2012, and was located 325 ft above mean sea level along a reach draining 149 mi^2 of the coastal plain. The Canning River discharged the highest volume of water with annual mean flow ranging from 1,502 to 1,961 cubic feet per second (ft^3/s) during the entire period of record. Annual mean flow on the Tamayariak ranged from 93.7 to 69.6 ft^3/s during the same period of record. Annual mean flow on the Hulahula River ranged from 489 to 745 ft^3/s from 2010 to 2016. The highest average monthly flows in the Canning and Tamayariak rivers occur during snowmelt in June. The highest average monthly flow in the glacier-fed Hulahula River, occurs during July.

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USGS

Pearce and others—**Summary of Wildlife-Related Research on the Coastal Plain ofhte Arctic National Wildlife Refuge, Alaska, 2002–17**—Open-File Report 2018–1003

ISSN 2331-1258 (online)
https://doi.org/10.3133/ofr20181003

From:	Brady, Stephanie
To:	Twitchell, Hollis
Cc:	Fox, Joanna
Subject:	Re: Arctic CCP scoping - list of places we scoped
Date:	Wednesday, February 14, 2018 4:08:15 PM

Thank you for the information. I will share with the BLM - Stephanie

stephanie_brady@fws.gov | Branch Chief, Conservation Planning and Policy |
U.S. Fish and Wildlife Service | National Wildlife Refuge System | Alaska |
907.306.7448

On Wed, Feb 14, 2018 at 1:10 PM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:

> I recommend Arctic Village, Venetie, Kaktovik, Barrow and Fort Yukon all be included for two reasons. 1) They all requested that they be informed and consulted with at a higher level than just to being sent updates. These village Tribal Councils all requested formal consultation at all stages of the plan's development. 2) Venetie, Arctic Village and Fort Yukon have many close relatives living within these communities. Same is true for Kaktovik and Barrow. Occasionally, families move back and forth between these villages.
>
> On Wed, Feb 14, 2018 at 11:42 AM, Fox, Joanna <joanna_fox@fws.gov> wrote:
>
> > BLM is trying to decide what communities need to be included in scoping for the leasing EA. Stephanie sent the list we used for the CCP, but that of course pertained to the entire refuge. Can you identify the villages you believe should be included in scoping for the BLM oil and gas leasing EA, with a rationale for each? I think Arctic Village, Kaktovik and Utviagvik should definitely be included, and probably Venetie as well - but not sure about Fort Yukon.
> >
> > ___________________________
> >
> > Joanna L. Fox
> > Deputy Refuge Manager
> > Arctic National Wildlife Refuge
> > 101 12th Avenue, Room 236
> > Fairbanks, AK 99701
> > (907) 456-0549
> >
> > Follow us on Facebook!
> > www.facebook.com/arcticnationalwildliferefuge
> >
> > *“Do what you can, with what you have, where you are.” -- Theodore Roosevelt*
> >
> > ---------- Forwarded message ----------
> > From: **Brady, Stephanie** <stephanie_brady@fws.gov>
> > Date: Wed, Feb 14, 2018 at 10:46 AM
> > Subject: Re: Arctic CCP scoping - list of places we scoped
> > To: "Miriam (Nicole) Hayes" <mnhayes@blm.gov>, "Fox, Joanna" <joanna_fox@fws.gov>
> > Cc: Wendy Loya <wendy_loya@fws.gov>, John Trawicki <john_trawicki@fws.gov>

sure - so the CCP revision included the entire refuge not just the 1002 area - therefore, we included villages that were adjacent to or within the boundaries of Arctic refuge - I am looping in Joanna Fox - it would be good to chat with her as you are developing a schedule for scoping. Stephanie

stephanie_brady@fws.gov | Branch Chief, Conservation Planning and Policy |
U.S. Fish and Wildlife Service | National Wildlife Refuge System | Alaska |
907.306.7448

On Tue, Feb 13, 2018 at 3:54 PM, Miriam (Nicole) Hayes <mnhayes@blm.gov> wrote:

> Thanks, Stephanie. Could you provide the rationale for including Fort Yukon and Venetie? I think Venetie is probably more cut and dry but I want to ensure if there are any places we don't scope that question why we didn't we have clear rationale.
>
> Thank you!
> Nicole
>
> Sent from my iPad
>
> On Feb 13, 2018, at 2:40 PM, Brady, Stephanie <stephanie_brady@fws.gov> wrote:
>
> Fort Yukon
> Arctic Village
> Venetie
> Washington, DC
> Anchorage
> Fairbanks
> Kaktovik
> Barrow
>
> stephanie_brady@fws.gov | Branch Chief, Conservation Planning and Policy |
> U.S. Fish and Wildlife Service | National Wildlife Refuge System | Alaska |
> 907.306.7448

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From: Mathews, Vince
To: Twitchell, Hollis
Subject: Re: Your thoughts on my first subsistence draft
Date: Wednesday, February 14, 2018 8:33:44 PM
Attachments: 1002 Subsistence Resource Assessment 2-14-18 VTM.docx

---

Hollis,

Attached is a file with my edits of 2-14-18 version. It looks fine.

On Wed, Feb 14, 2018 at 10:08 AM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:

> Vince, your edits are in a very early daft, not the one I sent out in my email. so I'm sending the latest draft out to you again with today date in the file name so you will know that your looking at the right one for review. I did incorporate your edits into today's draft where appropriate, thank you very much for that. Ed D sent an email response saying he does not have any expertise in subsistence but found it very informative. I am sending todays draft out to Steve, Joanna, Jen and Stephen Arthur for comments, before sending it to Region tomorrow.
>
> On Wed, Feb 14, 2018 at 7:07 AM, Decleva, Edward <edward_decleva@fws.gov> wrote:
>
> > Hi Hollis,
> >
> > I am not qualified in the field of subsistence, and I have no assigned responsiblity for the subject, so I cannot comment on its merits. I did read it though, and found it very informative. So thank you for the education.
> >
> > Edward J. DeCleva
> > Regional Historic Preservation Officer
> > U.S. Fish and Wildlife Service, Alaska Region
> > 1011 E Tudor Rd, MS-235
> > Anchorage, AK 99503
> >
> > edward_decleva@fws.gov
> > 907-786-3399
> >
> > On Tue, Feb 13, 2018 at 4:49 PM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:
> >
> > > What do you think, am I off base or going in the right direction.
> > >
> > > --
> > > Hollis Twitchell
> > > Assistant Manager
> > > Arctic Refuge
> > > 907 456-0512 w
> > > 907 378-5732 c
>
> --
> Hollis Twitchell
> Assistant Manager
> Arctic Refuge
> 907 456-0512 w
> 907 378-5732 c

--

Vince Mathews, Refuge Subsistence Specialist for Arctic, Kanuti, &Yukon Flats National Wildlife Refuges.
1-907-455-1823 or 1-800-531-0676 press 1 then 4 or cell: 907-947-9309
FAX: 456-0447
www.facebook.com/Kanuti.Refuge
www.facebook.com/YukonFlatsNationalWildlifeRefuge
www.facebook.com/arcticnationalwildliferefuge

We are not a Team because we work together. We are a Team because we respect, trust, and care for each other. @ValacAfshar

REPORTING TEMPLATE

> **Discipline/Subject Area:** Subsistence Use

> **Lead facilitator:** Hollis Twitchell, Arctic Refuge Assistance Manager, hollis_twitchell@fws.gov, 907-456-0512

> **Individuals contacted** : Nicole Hayes, BLM; Stacey Fritz, Mark Miller, BLM; BLM; Dan Sharp, BLM; Ed DeCleva, FWS; Vince Mathews, FWS; ADF&G Division of Subsistence; NSB Department of Wildlife Management.

> **What do we need to know and why regarding subjects?**

Subsistence Legal Mandates

- ANILCA Section 303(2)(B) sets forth the enabling purposes for Arctic National Wildlife Refuge, one of which is to: "(*iii)…*provide the opportunity for continued subsistence uses by local residents".

- Section 810(a) of ANILCA further states: "In determining whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands…the head of the Federal agency…over such lands…shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes. No such withdrawal, reservation, lease, permit, or other use, occupancy or disposition of such lands that would significantly restrict subsistence uses shall be affected until the head of such Federal agency…"

- In order to consider effects, we need to know the nature, extent and locations of subsistence resources and the cultural and subsistence practices of local residents and evaluate these along with specific oil and gas exploration and operations proposals. Kaktovik located on Barter Island is the only settlement near the 1002 area and would be the community most significantly affected. Kaktovik is an Iñupiat coastal community with a high dependence upon marine and inland resources for subsistence harvests.

Demograhics and Subsistence

- In 2010, Kaktovik's population was 239 persons with early 90 % of the population being of Native Iñupiat decent (Alaska Census Data, 2010). Participation in subsistence activities by Kaktovik households is high with 95.7 % of households using subsistence resources (ADF&G 2010). The subsistence way of life encompasses much more than just a way of obtaining food or natural materials. It involves traditions, which are important mechanisms for maintaining cultural values, family traditions, kinships, and passing on those values to younger generations. It involves the sharing of resources with others in need, showing respect for elders, maintaining a respectful relationship to the land, and conserving resources by harvesting only what is needed. Subsistence is regarded as a way of life, a way of being, rather than just an activity (Alaska Federation of Natives 2005).

Resource Seasonality and Access

- The community's harvest of subsistence resources can fluctuate widely from year to year because of variable seasonal migration patterns of marine and land based mammals, fish and waterfowl.

Subsistence harvesting techniques are extremely dependent on changing weather and surface conditions at sea and on land dramatically affecting ability to access resources. Determining when and where a subsistence resource will be harvested is a complex activity due to variations in seasonal distribution of animals, migration patterns, surface access conditions, severe weather events and often complex and changing hunting regulations. Human factors such as timing constraints (due to employment or other responsibilities), equipment (or lack thereof) to participate, and hunter preference (for one resource over another or for one sort of activity over another) are important components in determining the overall community pattern of subsistence resource harvest.

Mixed Subsistence and Market Economies

- Modern mixed subsistence-market economies require cash income sufficient to allow for the purchase of this mechanical equipment (boats and motors and snow machines) as well as the operational supplies such as fuel, oil, maintenance parts and equipment, firearms, ammunition, nets and traps, etc. Subsistence is focused toward meeting the self-sustaining needs of families and small communities (ADF&G 2000). Participants in this mixed economy supplement their subsistence harvests by cash employment from construction jobs, oil and gas industry jobs, commercial fishing, Alaska Permanent Fund or Native Corporation dividends and/or wages from the public or government services sectors. In Kaktovik, major employers are the North Slope Borough, City of Kaktovik and the Kaktovik Iñupiat Corporation. There are also a few private sector jobs and business such as grocery stores, motels, air carrier services and recreational wildlife viewing and boat transportation providers. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987).

Subsistence Uses and Conflicts with other Non-local Users

- Various members of the Kaktovik community and the Native Village of Kaktovik Tribal Council (NVK) have raised the issue of low flying planes and helicopters disturbing caribou on the coastal plain and disrupting local subsistence caribou and waterfowl hunters for many years. NVK states that low flying aircraft is causing the caribou to be displaced away from the coastal areas which they access to hunt in the summer and fall seasons. They attribute much of the low flying aircraft use to non-local caribou hunters and recreational scenic and wildlife viewing visitors. They have requested Arctic Refuge for a greater law enforcement presence to prevent this type of activity from harassing wildlife and causing the displacement of local subsistence resources away from the coastal plain areas they depend upon (Native Village of Kaktovik Tribal Council Meetings).

Subsistence Uses and Oil and Gas Development Conflicts

- During the January 12, 2010, Public Scoping meeting in Kaktovik for the Point Thomson Project EIS, subsistence users of the community expressed significant concerns regarding impacts from development of facilities, pipelines, roads, aircraft and operations, which could displace caribou and other important species away from coastal areas where subsistence harvesters could access them. In citing past history regarding the original Point Thomson drilling project they said there were many restrictions to subsistence hunting around the project area and they questioned how close subsistence hunters will be allowed to hunt near the drill pads, pipeline, and other facilities, and what new restrictions will be placed upon subsistence users with this new expanding Point Thomson development project (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Barging and fuel spills in marine waters continue to be a major concern as well as the proposed grounding of barges extending a significant distance from shore for lengthy periods of time. This

they believe will affect movement of seals and various species of fish which migrate through the area. There are further concerns about the exploration, production and scale of development, and the cumulative impacts of future development over time from other off-shore and inland fields, resulting in an even larger scale of impacts upon their subsistence resources and subsistence use opportunities. (Point Thomson EIS Kaktovik Scoping Meeting, 2010)

- Subsistence users stated there needs for base line studies to determine what fish, waterfowl and marine mammals are in the area, their health and population levels. This is necessary in case of a major spill or disruption of migration patterns and timing. They say baseline information is needed in case of a major oil spill and subsequent law suits, citing the case example of the Exxon Valdez oil spill (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- The issue of noise impacts to subsistence users was raised since Kaktovik people travel, camp and harvest in the 1002 area. Commenters stated that helicopter and aircraft traffic ~~above ground~~ and pipelines, roads and facilities ~~on the ground~~ would result in combined impacts likely to drive caribou and other wildlife further away from the coastal plain areas they hunt. Questions were raised on how much aircraft traffic and vehicle traffic on ice/winter roads and gravel roads will occur and what times of the year. (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Concerns were raised about air quality and environmental pollution caused by the burning (pilot purging and flaring) from oil and gas wells. Examples were given citing the black clouds and air pollution seen around the Prudhoe Bay oil fields. They say development of the Point Thomson oil and gas field will bring air pollution that much closure to the community of Kaktovik (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Concerns were expressed that the Point Thomson EIS project is looking only on the small scale, not the long term impacts of future field development and expansion. The project's cumulative impacts do not take into account future development of this field over time, or that of other off-shore and inland fields. The resulting larger scale impacts to resources and our subsistence opportunities are not being fully considered. For example they cite, Prudhoe Bay and all the other surrounding oil and gas field developments and their combined cumulative impacts upon subsistence opportunities (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

Subsistence Species Harvest Patterns

- Marine Mammals - In years when Kaktovik residents harvest and land a whale, marine resources have composed 59 to 68 % of their total subsistence harvest. Bowhead whaling occurs between late August and early October, with the exact timing depending on ice and weather conditions (Minerals Management Service 2003). There are at least 10 whaling crews in Kaktovik, and the community has a quota of three strikes (whether the animals are landed or not). Kaktovik has what is essentially an intercommunity agreement with Anaktuvuk Pass under which muktuk, whale meat and other marine mammal products (especially seal oil) are sent to Anaktuvuk Pass and Anaktuvuk Pass sends caribou and other land mammal products ~~are sent from Anaktuvuk Pass~~ to Kaktovik (Bacon et al. 2009). Other marine mammal hunting (mainly seals) can take place year-round. Kaktovik residents also harvest a significant number of bearded and smaller seals, and the occasional beluga whale or polar bear.

- Terrestrial Mammals - Land mammals are the next largest category of harvest, ranging from 17–30 percent in those same years. The primary land mammal resource is caribou, but Kaktovik residents also harvest a significant number of Dall's sheep. Of lesser abundance and availability are muskox, moose and grizzly bears. While Kaktovik hunters have taken moose and muskox, harvest opportunities are significantly restricted due to their low population numbers, the travel distance, weather, and associated fuel/parts/equipment costs. Kaktovik's annual caribou harvest

fluctuates widely because of the unpredictable movements of the herds, weather-dependent hunting technology, and ice conditions. Caribou hunting occurs throughout most of the year, with a peak in the summer when open water allows hunters to use boats to access coastal and lower coastal plain areas for caribou. In the winter with snow cover snowmachines are used to hunt inland coastal plain, foothills and the north slope drainages of the Brooks Range. Both the Porcupine and Central Arctic caribou herds are hunted when seasonally available. Dahl Sheep are hunted in winter when access by snowmachine is available.

- Fishery Resources - Fish comprise 8–13 % of the total subsistence harvests. Fish may be somewhat less subject to variable surface access conditions but still exhibit large year-to-year variations. In some winter months, fish may provide the only source of fresh subsistence foods. Kaktovik's harvest effort seems to be split between Dolly Varden and whitefish (Arctic Cisco), with the summer fishery at sites near Kaktovik being more productive than winter fishing on the mid and lower reaches of the Hulahula River.

- Bird Resources - Birds and eggs harvest makes up 2–3 % of the total harvest. Since the mid-1960s, subsistence use of waterfowl and coastal birds has been growing at least in seasonal importance. Most birds are taken during the spring and fall migrations. Important subsistence species are black brant, long-tailed duck, eider, snow goose, Canada goose, and pintail duck. Waterfowl hunting occurs mostly in the spring from May to early July (Minerals Management Service 2003). Ptarmigan are also a seasonally important bird.

- Furbearer Resources - Trapping of furbearers in the Kaktovik area has decreased with time. Furbearers are taken in the winter when surface travel by snowmachine is possible. Hunters pursue wolf and wolverine by searching and harvesting them with rifles primarily between March and April or in conjunction with winter sheep hunting. Some hunters may go out in the fall or early winter, but usually weather and snow conditions are poor at that time and people are more concerned with meat than with fur.

Subsistence Harvests Data

- Community subsistence harvest data for Kaktovik is dated in terms of the in-depth subsistence community use surveys, which were conducted in 1985, 1986, 1992 (ADF&G). In 1995, the North Slope Borough (NSB) began to systematically collect subsistence harvest data for the eight villages in the Borough. However, the NSB was only able to collect subsistence harvest data for the village of Kaktovik in 1994-1995 and in 2002-2003.

- Subsistence harvest studies for Kaktovik in 1995 indicated that 61% of the subsistence harvest (in edible pounds of food) were from marine mammals, consisting of bowhead whales, bearded seals, ringed seals, spotted seals, polar bears, and beluga whales. Terrestrial mammals comprised another 26% of the estimated edible pounds harvested, consisting of caribou, Dall's sheep, muskox, moose, and brown bear. Fishery resources accounted for 11% of the estimated total edible pounds of harvest. Seven species of fish accounted for the 4426 fish harvested of which Arctic Cisco and Dolly Varden represented 4233 of the fish caught. The harvest of birds accounted for the remaining 2% of edible pounds of subsistence harvest with 530 birds reported harvested (Brower et al 2000).

- In addition to the Beaufort Sea, Kaktovik residents have access to a number of rivers and lakes, which support significant subsistence fish resources. Pedersen and Linn (2005) conducted surveys of the Kaktovik subsistence fishery in 2000-2001 and 2001-2002, with estimated community harvests of fish at 5,970 pounds and 9,748 pounds, respectively. Dolly Varden, lake trout, and Arctic Cisco were the only fishery resources reported harvested by Kaktovik households in this study. Dolly Varden was the most commonly harvested fish in terms of

numbers harvested and estimated harvest weight, with Arctic Cisco and lake trout ranking second and third (Pedersen and Linn, 2005).

> **What information is currently available to address the information needs for subjects?**

- The most recent and thorough publication with information regarding Kaktovik's subsistence and traditional land/marine water use patterns were prepared for the US Army Corps of Engineers Point Thomson Project EIS and published in July 2012. Appendix Q of the final EIS and Environmental Impact Statement contains the information on the "Subsistence and Traditional Land Use Patterns for Kaktovik and Nuiqsut" which was prepared by Stephen Braund and Associates at the request of HDR Alaska for the US Army Engineer District Alaska Regulatory Division.

- The Point Thomson Project is located adjacent to Arctic National Wildlife Refuge on coastal plain approximately 60 miles west of Kaktovik. In describing the affected environment for subsistence, the study team reviewed the Point Thomson Environmental Report (ER) (ExxonMobil 2009), as well as other sources of subsistence data including harvest amount data obtained from the Alaska Department of Fish and Game (ADF&G) Division of Subsistence and North Slope Borough (NSB) Department of Wildlife Management subsistence publications. The ER included harvest data for the majority of available study years. Appendix Q includes additional harvest amount and harvest location data, including unpublished subsistence harvest data from the ADF&G Division of Subsistence and the NSB Department of Wildlife Management acquired in 2002 and unpublished subsistence harvest data acquired from the NSB in 2010. It incorporates additional data from previous Environmental Impact Statement (EIS) efforts, including issues raised during a Point Thomson EIS meeting on caribou in 2002 and subsistence use area data collected in Kaktovik in 2003. Finally, this affected environment incorporates 1995-2006 subsistence use areas collected during a Minerals Management Service (MMS) funded subsistence mapping project in Kaktovik and Nuiqsut (SRB&A 2010a).

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Pedersen, S. and M. Coffing. 1984. Caribou Hunting: Land Use Dimensions and Recent Harvest Patterns in Kaktovik, Northeast Alaska. Technical Paper No. 92. ADF&G Division of Subsistence. Juneau, Alaska.

Pedersen, S., M. Coffing, and J. Thompson. 1985. Subsistence Land Use and Place Names Maps For Kaktovik, Alaska. Technical Paper No. 109. ADF&G, Division of Subsistence. Fairbanks, Alaska.

Wolfe, R.J. and R.J. Walker. 1987. Subsistence Economies in Alaska: Productivity, Geography, and Development Impacts. *Arctic Anthropology* 24(2):56-81.

> **What are key information gaps?**

- Currently there is no complete synthesis of cultural work (subsistence, historical, and archaeological) that has been conducted in the Arctic Refuge as a whole or in particular for the northern half of the Refuge. A limited number of archeological and historical resource surveys have taken place on the Refuge due to funding, logistical difficulties of working in remote locations and lack of infrastructure to support investigations in the Refuge. A more through and complete synthesis of what work has been completed and in what areas would help identify informational gaps and help set priorities for future work.

- Community subsistence harvest data for Kaktovik is dated in terms of the in-depth subsistence community use surveys, which were conducted in 1985, 1986, 1992 (ADF&G). In 1995, the North Slope Borough (NSB) began to systematically collect subsistence harvest data for the eight villages in the Borough. However, the NSB was only able to collect subsistence harvest data for the village of Kaktovik in 1994-1995 and in 2002-2003. There needs to be a more through and consistent collection of community subsistence harvest information.

- In 2010, Morgan Grover of the US Army Corps of Engineers conducted a survey of 70 known cultural sites along the coastal areas from Flaxman Island to the Canadian border (including the 1002 area) to examine the effects of environmental changes and erosion has had on these sites over the past 30 years. The study concluded that of the 69 previously reported cultural sites, 21 were found to be impacted to some extent by erosion or thermokarsting, and 20 had been completely eroded away. She concludes that many of the remaining cultural sites are in imminent threat of eroding in the next decade. Follow-up studies and research is needed to recover cultural information before it is lost to erosion. The report strongly recommended that selected threatened sites be documented and potentially excavated after consultation and agreement with Tribal leaders.

- In 2010, Jake Anders conducted a brief archeological survey in the eastern end of the Sadlerochit Mountains just outside and south of the 1002 area. Nine archeological sites were located, eight of which have not been previously reported. The discovery of these sites has greatly increased the number of known archeological sites in this particular area of the Refuge, and suggests that the pre-contact indigenous land use of the northern foothills of the Brooks Range was more

intense than has previously been thought. There is a need to conduct further cultural resources surveys within the uplands and hills of the 1002 area.

- In 1982, Ed Hall conducted an inventory and survey of archaeological and historical resources in the 1002 area examining areas of high archaeological and historical potential. The areas surveyed were focused on areas proposed for exploratory drilling for oil and gas and areas more likely to have cultural sites such as coastal areas and barrier islands, and along rivers and streams that crossed the 1002 area, and high points of land that have overlooks above the surrounding tundra. There is a need to reassess these areas since visitors and users have reported several graves, human remains and artifacts in these areas that have not been documented and record by professional cultural resource staff.

> **What studies/surveys need to be conducted to fill those information gaps?**

- Hire one Archeologist/Anthropologist GS-11/12: USFWS should hire an archeologist or anthropologist to oversee the agency's cultural resource management/compliance programs during the seismic, exploration and production phases of the oil and gas development associated with the 1002 area of the coastal plain.

- Manage Subsistence Use Data: Compile a complete synthesis of archaeological, ethnographic and subsistence work that has been completed for Arctic Refuge's north slope and 1002 areas and create a functional repository of existing contemporary and historical data. Multiple sources of published and unpublished subsistence use and harvest data reside with various agencies, organizations, tribal governments, and universities.

- Identify gaps in data: A comprehensive review of existing information is needed to identify gaps in the data and to identify priorities for future subsistence research and monitoring. This information is needed to ensure traditional subsistence use and knowledge is thoroughly and accurately considered in Federal and State proposals for subsistence regulations, as well as Refuge management actions including oil and gas development in the 1002 area.

- Subsistence Harvest Monitoring Program: A NSB/Kaktovik community supported harvest monitoring program with implementation protocols based on timely and accurate harvest information is needed to ensure long-term conservation of subsistence species of fish and wildlife and subsistence uses for qualified subsistence users. The majority of the ethnographic and subsistence data for Kaktovik and the 1002 area was collected in the 1980s and may not accurately portray current patterns in subsistence use, demographics, harvest amounts, hunting seasons, locations, or community needs.

- Conduct Oral Histories and Traditional Knowledge Study: Much valuable cultural, historic, and traditional ecological knowledge about the Refuge and the coastal plain (1002 area) is possessed by local elders. Oral histories and place names contain an enormous amount of information on traditional uses, culturally important places, historic camps and settlements, and other natural and cultural information. This information is an untapped archive that could potentially benefit historical site protection and guide management decisions setting priorities for surveys and research in the 1002 area.

From:	Fischbach, Tracy
To:	Twitchell, Hollis
Cc:	Steve Berendzen; Fox, Joanna; Stephen Arthur; Jennifer Reed; Decleva, Edward
Subject:	Re: Draft Subsistence Resource Assessment
Date:	Thursday, February 15, 2018 8:52:13 AM

Hi Hollis,

Thank you for sending this out. There's a lot of great information here, especially in regards to potential conflicts based on what is happening at Point Thomson. If we can learn from the issues there, that will be a big step forward.

My comments are general in nature, so I've just included them here. One question I had from the beginning is why Arctic Village was not included. I think they will be pretty outspoken about the effects of oil & gas production on their subsistence activities, primarily focused on caribou. We may want to be sure to include any information regarding that issue in this paper. Also, if someone can take a moment to gather email addresses and phone numbers for the folks listed as contacts that will really help John and Wendy out. Also, keep in mind that Wendy and John are going to pull out just the information regarding knowledge gaps and needs for this exercise. You may want to consider creating a "short" document that focuses on that question. Most of the tech teams are doing this. It's important to get all the information down, but we all want to be sure that the info that John and Wendy pull into their summary report will be what we feel is most crucial.

Subsistence is going to be one of the main drivers in the analysis, so all the information we can gather in this area is going to be very important.

Thanks again,
-Tracy

Tracyann S Fischbach
Natural Resources Planner
National Wildlife Refuge System - Region 7
Division of Natural Resources & Conservation Planning
(907) 786-3369

Hours: Mon - Thurs 6:30 am to 4:00 pm; Friday 9:00 am - 1:00 pm
"Getting right down and smelling the fresh soil is good for any one." - from the 1913 Handbook for Girl Scouts by W. J. Hoxie

Need access to Refuge Documents?
Online Document Database (ServCat)
Need Refuge land status info for Alaska?
FWS Region 7 Land Mapper (FWS version)
FWS Region 7 Land Mapper (Public version)
Region 7 GeoPDF Map Portal

On Wed, Feb 14, 2018 at 10:17 AM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:

> Attached please find the draft Subsistence Resource Assessment for your comments and suggestions. Thanks.
>
> --
> Hollis Twitchell
> Assistant Manager
> Arctic Refuge

907 456-0512 w
907 378-5732 c

From:	Wendy Loya
To:	John Trawicki; John Martin; Greta Burkart; Paul Leonard; Angela Matz; Tracy Fischbach; Roger Kaye; Randy Brown; Christopher Latty; Stephen Arthur; Christopher Putnam; Edward Decleva; Hollis Twitchell
Cc:	Drew Crane; Richard Lanctot; Eric Taylor
Subject:	Drive Location for uploading 1002 Arctic Refuge Resource Assessments
Date:	Thursday, February 15, 2018 2:36:41 PM
Importance:	High

Dear Resource Assessment Team Leads:

We have established a shared folder on the R7 Common Drive for the 1002 Arctic Refuge Program (Oil and Gas). It should look like this, and you can use FWS Tools to go in your computer menu to get to a link called Drives, which leads to a link to Remap Drives and Printers. Let me or John Trawicki know if you are unable to find the folder.

r7common(\\ifw7rofs1.fws.doi.net)(P:)\1002ArcticRefuge\1-Working\Resource Assessments_Originals

Everyone in the region should have read/write access to this folder, and I would like to request that you please save a copy of your final document there in addition to emailing it to John Martin. If you have already submitted, John Martin will save the copy he has received there today. This will allow us to work with these immediately and keep common record of the effort.

Thank you,
Wendy

Dr. Wendy M. Loya, Coordinator
Arctic Landscape Conservation Cooperative (LCC)
Anchorage, Alaska
907.786.3532 (office)
907.227.2942 (mobile)

From:	ssweet@blm.gov
To:	Greta Burkart; Edward Decleva; Janet Jorgenson; Paul Leonard; Christopher Latty; Ryan Wilson (ryan_r_wilson@fws.gov); Roy Churchwell; Stephanie Brady; Steve Berendzen; Drew Crane; John Trawicki; Richard Lanctot; Eric Taylor; Charles Hamilton; John Martin; Stephen Arthur; Hollis Twitchell; Roger Kaye; Tracy Fischbach; Angela Matz; Jennifer Reed; Randy Brown; Mark Miller
Subject:	FW: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop Presentation

Hi FWS colleagues,
A reminder about the Arctic seismic presentation today at 10am-12pm AK time. The presentation will be broadcast as a webinar from BLM Fairbanks, and you can join online or in person at BLM in Anchorage downtown (Kodiak Room on 4th foor), in the Science Applications room at the FWS Regional Office or in the Refuges Conference Room in Fairbanks.
Hope you can participate,
Wendy

Dr. Wendy M. Loya,
Arctic Program Coordinator, Office of Science Applications
US Fish and Wildlife Service
Anchorage, Alaska
907.786.3532 (office)
907.227.2942 (mobile)

-----Original Appointment-----
From: ssweet@blm.gov <mailto:ssweet@blm.gov> [mailto:ssweet@blm.gov] On Behalf Of ssweet@blm.gov <mailto:ssweet@blm.gov>
Sent: Monday, February 05, 2018 11:43 AM
To: ssweet@blm.gov <mailto:ssweet@blm.gov> ; wendy_loya@fws.gov <mailto:wendy_loya@fws.gov> ; dwixon@blm.gov <mailto:dwixon@blm.gov> ; njones@blm.gov <mailto:njones@blm.gov> ; mnhayes@blm.gov <mailto:mnhayes@blm.gov> ; joanna_fox@fws.gov <mailto:joanna_fox@fws.gov> ; john_trawicki@fws.gov <mailto:john_trawicki@fws.gov> ; wsvejnoh@blm.gov <mailto:wsvejnoh@blm.gov> ; ctburns@blm.gov <mailto:ctburns@blm.gov> ; tracy_fischbach@fws.gov <mailto:tracy_fischbach@fws.gov> ; john_w_martin@fws.gov <mailto:john_w_martin@fws.gov> ; drew_crane@fws.gov <mailto:drew_crane@fws.gov> ; zlyons@blm.gov <mailto:zlyons@blm.gov> ; paul_leonard@fws.gov <mailto:paul_leonard@fws.gov> ; Eric Taylor; rbrumbau@blm.gov <mailto:rbrumbau@blm.gov> ; stephanie_brady@fws.gov <mailto:stephanie_brady@fws.gov> ; mdraper@blm.gov <mailto:mdraper@blm.gov> ; steve_berendzen@fws.gov <mailto:steve_berendzen@fws.gov>
Subject: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop Presentation
When: Friday, February 16, 2018 10:00 AM-12:00 PM (UTC-09:00) Alaska.
Where: Bridge b5-CIP [redacted] Passcode b5-CIP [redacted] (Webex: b5-CIP [redacted] BLM-AK SO Kodiak A Room, BLM-AK SO Kodiak B Room

For those of you attending in person at the Federal Building, the meeting will be held in the Kodiak Room on the 4th floor.

From:	Wendy Loya
To:	Hollis Twitchell
Subject:	FW: FW: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop Presentation
Date:	Friday, February 16, 2018 10:28:08 AM

Hi Hollis,

Can you not see the invite in the first email I sent? Here is the message I included. The Refuges conference room is reserved to show the webinar, or you can join from your office via webinar.
Bridge b5-CIP [redacted], Passcode b5-CIP [redacted]
Webex: b5-CIP [redacted]

A reminder about the Arctic seismic presentation today at 10am-12pm AK time. The presentation will be broadcast as a webinar from BLM Fairbanks, and you can join online or in person at BLM in Anchorage downtown (Kodiak Room on 4th foor), in the Science Applications room at the FWS Regional Office or in the Refuges Conference Room in Fairbanks.

Dr. Wendy M. Loya,
Arctic Program Coordinator, Office of Science Applications
US Fish and Wildlife Service
Anchorage, Alaska
907.786.3532 (office)
907.227.2942 (mobile)

From: Twitchell, Hollis [mailto:hollis_twitchell@fws.gov]
Sent: Friday, February 16, 2018 8:24 AM
To: Wendy Loya
Subject: Re: FW: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop Presentation

Not on my calendar, when and where is the meeting.

2018-02-16 8:09 GMT-09:00 Wendy Loya <wendy_loya@fws.gov>:

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From: Wendy Loya
To: Greta Burkart; Edward Decleva; Janet Jorgenson; Paul Leonard; Christopher Latty; Ryan Wilson; Roy Churchwell; Stephanie Brady; Steve Berendzen; Drew Crane; John Trawicki; Richard Lanctot; Eric Taylor; Charles Hamilton; John Martin; Stephen Arthur; Hollis Twitchell; Roger Kaye; Tracy Fischbach; Angela Matz; Jennifer Reed; Randy Brown; Mark Miller; Donna Wixon; Nichelle (Shelly) Jones; Miriam (Nicole) Hayes; Joanna Fox; Wayne Svejnoha; Casey Burns; Lyons, Zachary C; Robert Brumbaugh; Marlo Draper
Subject: Clarification: BLM Arctic Seismic Process - Follow-up to 1/19 Workshop Presentation
Date: Friday, February 16, 2018 10:32:47 AM

Hi again everyone,

I have heard that the information in my email did not come across clearly, I apologize and will be sure not to use Outlook to forward invitations. Here is what I wanted to share with you:

A reminder about the Arctic seismic presentation today at 10am-12pm AK time. The presentation will be broadcast as a webinar from BLM Fairbanks, and you can join online or in person at BLM in Anchorage downtown (Kodiak Room on 4th foor), in the Science Applications room at the FWS Regional Office or in the Refuges Conference Room in Fairbanks.

Bridge b5-CIP [redacted], Passcode b5-CIP [redacted]

Webex: b5-CIP [redacted]

Thank you for your feedback,

Wendy

Dr. Wendy M. Loya,

Arctic Program Coordinator, Office of Science Applications

US Fish and Wildlife Service

Anchorage, Alaska

907.786.3532 (office)

907.227.2942 (mobile)

From:	Berendzen, Steve
To:	Twitchell, Hollis
Cc:	Joanna Fox
Subject:	Re: Very near final draft Subsistence Resource Assessment
Date:	Friday, February 16, 2018 11:07:36 AM

Hollis, my changes did not save. They were editorial & nothing major, so maybe I can do it again if I get a chance. I had opened the document in edit mode, but couldn't find any way to save the changes. Not going to try that again unless I'm sure they'll save.

Steve Berendzen
Acting Manager, Arctic National Wildlife Refuge
907-456-0253

On Fri, Feb 16, 2018 at 8:12 AM, Steve Berendzen <steve_berendzen@fws.gov> wrote:

> Hollis, I couldn't figure out track changes in Google docs, so I just made them in the doc as permanent changes with none of the previous spellings remaining. Hopefully it was saved that way
>
> Sent from my iPhone
>
> On Feb 16, 2018, at 6:43 AM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:
>
> Morning Steve, I am looking for your edits and changes in the draft document and don't see them. Did you do your edits in track changes, or highlight them in a different color? Or did you save them in a different document under a different file name, but did not attach it in your email response? If so, please send it to me. Appreciate knowing what you would like changed. Note: Ed did not list in his Cultural Resource Assessment gap items I listed in the Subsistence Assessment other that the need for a full time archaeologist. Attached is his Cultural Resource Assessment he turned in.
>
> On Thu, Feb 15, 2018 at 10:07 PM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:
>
> > Hollis, I reviewed and made some editorial changes, but nothing to the context of what you have. It all looks really good, but I'm curious if the "Gaps" portion that includes the archaeological reports and studies is also in the cultural resources assessment? It seems like it would fit better in that.
> >
> > Steve Berendzen
> > Acting Manager, Arctic National Wildlife Refuge
> > 907-456-0253
> >
> > On Thu, Feb 15, 2018 at 3:53 PM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:
> >
> > > Just waiting for the last few comments, will submit final tomorrow.
> > >
> > > --
> > > Hollis Twitchell
> > > Assistant Manager
> > > Arctic Refuge
> > > 907 456-0512 w

> > 907 378-5732 c

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

<1002 Cultural Resource Assessment - DeCleva.pdf>

From:	Churchwell, Roy
To:	Latty, Christopher
Subject:	Re: Coastal Plain 1002 Area Final Guidance for Reporting Template
Date:	Friday, February 16, 2018 11:14:07 AM
Attachments:	REPORTING TEMPLATE Birds 2-16-18 RTC.docx

Chris,

Here are my thoughts. Just a few suggesting sprinkled throughout. As far as Rick's comments versus your comments, I think you both were saying the same thing for the most part, and so which version you pick in the end probably doesn't matter. I do agree with Rick that active voice is better than passive voice grammatically, but I know a lot of people write in passive voice still and it gets the point across. So, I didn't change those. Anyway, hope my comments are helpful.

Roy

On Thu, Feb 15, 2018 at 11:00 PM, Latty, Christopher <christopher_latty@fws.gov> wrote:

> And here is my latest version. It includes a lot of Rick's stuff, but not all as some I'm not really in agreement with in the broad management context we have been discussing the last few days. I'll be curious to hear your thoughts.
>
> Also, you will notice the surveys/studies section has been simplified. This was as the encouragement of Ted, but I still don't know how I feel about that since Wendy is in charge of this and encouraging more details (which I also think is problematic at this very early stage).
>
> On Thu, Feb 15, 2018 at 10:11 PM, Latty, Christopher <christopher_latty@fws.gov> wrote:
>
>> Can you look through these and let me know which you agree and disagree with.
>>
>> ---------- Forwarded message ----------
>> From: **Lanctot, Richard** <richard_lanctot@fws.gov>
>> Date: Thu, Feb 15, 2018 at 6:55 PM
>> Subject: Re: Coastal Plain 1002 Area Final Guidance for Reporting Template
>> To: "Latty, Christopher" <christopher_latty@fws.gov>
>>
>> Hi Chris,
>>
>> I ran out of time to work on this more but got most of the way through the document. It looks red but most are rephrasing into active voice. I can work on again in the morning but know you are a night owl so might want it now.
>>
>> Cheers, Rick
>>
>> ***
>> Richard Lanctot, PhD
>> Region 7 Shorebird Coordinator

U.S. Fish and Wildlife Service
1011 East Tudor Road, MS 201
Anchorage, Alaska 99503
Ph: 907-786-3609
Fax: 907-786-3641
Cell: 907-440-9733
E-mail: richard_lanctot@fws.gov

****
"Hockey is Life - Keep your stick on the ice!" Unknown author

On Wed, Feb 14, 2018 at 10:19 PM, Latty, Christopher <christopher_latty@fws.gov> wrote:

> Curious if you had a chance to look at the latest version? If not, and you are able on Thursday, here is a slightly updated version...
>
> On Tue, Feb 13, 2018 at 11:19 PM, Latty, Christopher <christopher_latty@fws.gov> wrote:
>
>> Latest version...
>>
>> On Tue, Feb 6, 2018 at 1:40 PM, Latty, Christopher <christopher_latty@fws.gov> wrote:
>>
>>> Thanks Rick!
>>>
>>> On Tue, Feb 6, 2018 at 12:05 PM, Lanctot, Richard <richard_lanctot@fws.gov> wrote:
>>>
>>>> Hi Chris,
>>>>
>>>> Here are the two data sets I have for the 2002 and 2004 ANWR surveys. Only the 2004 data set has non-shorebirds included (unless I missed something).
>>>>
>>>> I do think more tracking studies are in order since I am sure there is yearly variation and we haven't tracked many of hte species to date.
>>>>
>>>> I put a fair number of comments/edits in your document. It seems that we need to really differentiate and be consistent in what goes in the various major sections. Right now justifications, issues, etc. jump back and forth between sectins. Thanks to you and Roy for making the first stab at this.
>>>>
>>>> Cheers, Rick
>>>>
>>>> ***
>>>> Richard Lanctot, PhD
>>>> Region 7 Shorebird Coordinator
>>>> U.S. Fish and Wildlife Service
>>>> 1011 East Tudor Road, MS 201
>>>> Anchorage, Alaska 99503
>>>> Ph: 907-786-3609
>>>> Fax: 907-786-3641
>>>> Cell: 907-440-9733

E-mail: richard_lanctot@fws.gov

****
"Hockey is Life - Keep your stick on the ice!" Unknown author

On Mon, Feb 5, 2018 at 1:13 PM, Latty, Christopher <christopher_latty@fws.gov> wrote:

> Thanks Rick!
>
> I'll followup with folks about the non-shorebird data from the 02/04 PRISM again. Based on the Bart chapter in the shorebird monitoring book and NPRA paper he was lead author on I thought it was both years. I'll continue to explore who might have this data since it sounds like neither mig birds or Manoment have it.
>
> Do you think we need more tracking studies (ie > sample sizes and species)? I guess I'm of the opinion that we do for specific questions that might relate to identifying phenology and site use specifically for the 1002 sites.
>
> I believe Steve Arthur is putting tracking fox in his "other" species assessment, but I'll follow up.
>
> How do I get involved in the group? FYI - I'm hoping to get Lisa Kennedy to help at the Canning this summer (I believe you met her at the AK Shorebird meeting and maybe prior). It should be doable to include tiny tags on 20 dunl and sesa (assuming the dunl can be done over multiple years since we only get about 10ish nests).
>
> So here is what Roy and I came up with for the draft Resource Assessment. Dave Payer is reviewing it now, but I'd love to get your input on it as soon as possible. My thought is to share it was Wendy Loya after getting a few folks feedback soon (hopefully tomorrow?) to see if it provides what she wants, then I'll send it along to Julian, John Pearce, and the BLM folks (I just found out Deb Nigro is out this week), and others hopefully by Wednesday.
>
> As always - thanks for all your help with this process! I'd be lost without folks like yourself with tons and tons of insight
>
> Cheers
> Chris
>
> On Fri, Feb 2, 2018 at 5:26 PM, Lanctot, Richard <richard_lanctot@fws.gov> wrote:
>
>> see a few other points in Blue.
>>
>> Rick
>>
>> ***
>> Richard Lanctot, PhD
>> Region 7 Shorebird Coordinator
>> U.S. Fish and Wildlife Service

1011 East Tudor Road, MS 201
Anchorage, Alaska 99503
Ph: 907-786-3609
Fax: 907-786-3641
Cell: 907-440-9733
E-mail: richard_lanctot@fws.gov

****
"Hockey is Life - Keep your stick on the ice!" Unknown author

On Fri, Feb 2, 2018 at 2:42 PM, Latty, Christopher <christopher_latty@fws.gov> wrote:

> Thanks Rick! Great points and I really appreciate your help with this!
>
> Couple of followup questions in red in the text :)
>
> Roy - please also weigh in.
>
> On Fri, Feb 2, 2018 at 4:23 AM, Lanctot, Richard <richard_lanctot@fws.gov> wrote:
>
>> Hi Chris,
>>
>> I put comments in CAPS in your letter below.
>>
>> The big question is really what happens to birds that are displaced by the oil and gas pad developments (places where there is clear loss of habitat). Do they just get absorbed into the surrounding tundra or do they suffer lower nesting opportunities, lower survival, etc.   It goes back to the old question of "is the hotel (i.e. tundra) empty, partially empty, or full". I know of one study at Barrow where Dick Holmes shot a bunch of dunlin and the territories were immediately filled in with new dunlin. This suggested that there were lots of floaters in the population and that the hotel was full. If this is true, then displacement of birds could have big impacts on at least their productivity (or the productivity of birds that were displaced by the displaced birds). Along these lines, we also have a paper submitted that shows that shorebird nests are reused from year to year, and that certain species (AMGP) frequently use the same nest bowls across years (both the same and different individuals). This suggests that certain sites are more valuable than others and disturbance of these sites could have bigger effects than disturbance at other sites. This implies that citing oil facilities is not as simple as "stay in the dry areas and avoid the wetlands", which seems to be the approach. But having said this, this approach is still likely the best to minimize harm to the most species.
>>
>> I am just rambling but it would be nice to tackle this question if possible.
>>
>> Cheers, Rick
>>
>> ***
>>
>> Richard Lanctot, PhD
>> Region 7 Shorebird Coordinator
>> U.S. Fish and Wildlife Service
>> 1011 East Tudor Road, MS 201
>> Anchorage, Alaska 99503
>> Ph: 907-786-3609
>> Fax: 907-786-3641

Cell: 907-440-9733
E-mail: richard_lanctot@fws.gov

****
"Hockey is Life - Keep your stick on the ice!" Unknown author

On Thu, Feb 1, 2018 at 10:37 PM, Latty, Christopher
<christopher_latty@fws.gov> wrote:

Hi Rick,

Here is a draft email I'm planning to send to some of the other folks working on the various parts of this document. If you have a chance in the morning I would greatly value your input to see if I captured the key points of today's discussion, and also I'm curious what basic information needs you think are most important to include in this first exercise.

Thanks much!

Cheers
Chris

Hi all,

Today we had a phone call with Wendy Loya and John Martin to further discuss the expectations, topics to include, and level of detail for the INITIAL Resource Assessments DUE ON 16 FEBRUARY. One of the main takeaways I had from today's meeting (Roy and Rick please weigh in if you disagree) is the need for simplicity and not getting to far in the weeds at this point. It appears there are really 3 topics we should be considering when deciding what to include in the document: 1) information to inform preliminary management decisions or recommendations for exploration (which will include both roving seismic teams and camps from Dec-May of up to 150 people

, AND THE AFTERMATH FROM THIS PROCESS [ICE ROADS MELTING OFF LATE, BROWNING AND COMPRESSION OF GRASSES, EXTRACTION OF WATER FOR CAMPS]

), 2) information to inform management decisions or recommendations for leasing (

E.G., WHAT SITES ARE LIKELY MOST IMPORTANT TO BIRDS WHILE RECOGNIZING THAT HORIZONTAL DRILLING CAN GO

OUT TO 6 MILES NOW ;

and 3) baseline information that we expect will be important when we conduct broader needs

AND IMPACT

assessments for actual development later on, but that cannot be done in just a short 2-3 year study.

Given we are talking about 150 species, I think we need to keep the "needs" list broad, then we can break it down by species groups in the sections dealing with existing data we have, the remaining gaps, and specific projects to fill those gaps. So what I'd like to do is come up with 3-5 broad "information needs" we have to address the 3 topics above. Here are a few based on my initial thoughts:

1. Determine

CONTEMPORARY NUMBERS AND DISTRIBUTION OF PRE-, BREEDING, AND POST-BREEDING bird S AND THEIR habitat ASSOCIATIONs in the 1002 Area. THIS MAY FOCUS ESPECIALLY IN AREAS LIKELY TO BE DEVELOPED (I.E., CLOSE TO POINT THOMSON) AND KNOWN TO PREVIOUSLY HAVE GOOD BIRD NUMBERS. Much nicer wording than mine! For this latter, while we have 1 years worth of data for shorebirds from PRISM, we don't have the same level of info for other species. And if we do look back at the 30+ year old data from the original 1002 work, the Canning did not have the highest densities.

*** apparently we do have abundance data for all birds from the 2002 survey but not the 2004 survey. Not sure why it changed.

2. Determine when those key areas and habitats are primarily used. I think this is is straightforward for breeding birds, and we have good data for juvenile shorebirds in the fall from Roy and Stephen's work on the coast. But I believe we are lacking info on the timing of CURRENT use of these habitats in spring (I expect at least for coastal birds this is driven by availability more than anything else). And for post-breeding, at least in talking to Roy we do not seem to have a good sense of post-breeding habitat use for adult shorebirds, and for waterbirds, the data we do have is at least 20 years old and other data would suggest that climate change would have caused the dates to change. We also do not have data for other species groups.

*** keep in mind that the tracking projects will hopefully generate information on post-breeding movements.

3. Conduct baseline assessments of factors limiting the population size of birds in the 1002 Area, and specifically, assessments of anthropogenic factors known to have negatively affected birds at

existing developed Arctic coastal plain sites (I envision this topic covering both how information from NPRA/Prudhoe may or may not be applicable to the 1002, as well as the need for baseline info on predators that may increase in abundance post-development).

<<< THE LATTER OBJECTIVE NEEDS TO BE MORE SPECIFIC IN HOW IT RELATES TO OIL AND GAS DEVELOPMENT. I GET WANTING CURRENT INFORMATION ON PREDATOR NUMBERS AND THEIR CURRENT IMPACTS ON BIRD NESTING SUCCESS, BUT GIVEN THE LARGE INTER-ANNUAL VARIABILITY IN THIS BASED ON PRIOR DATA COLLECTION, I AM NOT SURE IT IS THAT USEFUL. WHAT OTHER FACTORS WOULD YOU FOCUS ON? >>My thoughts were that this is universally the most commonly documented effect of development and that the large variability in annual fox populations (and also makeup/density of the egg predator community more broadly) is the reason we need to begin collecting this data now, and not put if off for a 2-3 year study later on. In my humble opinion :) this is often one of the major issues when folks examine the effect of development on subsidized predators and their prey. I would suggest often their power to find even a relatively large effect is low because of the noisy data collected for a short period of time without an ability to add covariates that might help lower that background variability. It sounds like you would disagree with that notion, correct?

*** I have been trying to document effects of a variety of factors on nest success in shorebirds at Barrow for 15 years and I still don't think I have enough data to account for variation in snow melt, summer temperatures, bugs, predators, lemmings, etc. A better approach may be to follow the fox around and assess their diet consumption in areas now versus after the development occurs. I have never done this though so may it is equally messy.

<<< PERHAPS, WE COULD SUGGEST FOCUSING ON GATHERING INFORMATION ON BASELINE LEVELS OF CONTAMINANTS IN THE BIRDS, PATTERNS OF NEST ATTENTATIVENESS, OR OTHER FACTORS THAT COULD CHANGE AFTER A OIL FIELD IS ESTABLISHED. NOT SURE >>Contaminants would be good to assess, but this is one of those potential effects that has been well studied in Prudhoe and they found those birds are not generally exposed to levels of local contaminants that are known to be harmful. That said there are some new techniques to track the exposure of hydrocarbons (which is tough since it is quickly metabolized) that we should definitely include. Nest attentiveness is another one that (at least for geese) was recently shown not to be affected by a bunch of industrial activity in NPRA. That said, GWFG are probably one of the species least likely to be affected by random industrial disturbance (ie not flushing the bird off the nest) based on nesting ecology, so I agree this should be examined for other species. But would this be one of those things that we could address later with just a couple years worth of data (SIDE NOTE - I do want to examine this beginning this summer at the Canning and am getting some Tiny Tags from the Canadians; would you have any Tiny Tags I could borrow this summer?).

**** We are also putting out tiny tags as part of a larger circumpolar effort to look at factors affecting nest success. You may want to join the group - it requires measuring herbivory

(transects and counting poops), putting out artificial quail nests and assessing predation, measuring lemming abundance (we do incidental sighting summaries), and measuring avian predators, and finally putting tiny tags under 20 DUNL and 20 SESA nests to get good estimates of nest survival times. Thus all my tiny tags are being used this year.

* ** I would be interested in knowing more about measuring hydrocarbons.

Please let me know your thoughts on these and what others should be considered.

Thanks much!!

Cheers

Chris

---------- Forwarded message ----------
From: **Martin, John** <john_w_martin@fws.gov>
Date: Wed, Jan 31, 2018 at 4:14 PM
Subject: Coastal Plain 1002 Area Final Guidance for Reporting Template
To: Janet Jorgenson <janet_jorgenson@fws.gov>, Tracy Fischbach <tracy_fischbach@fws.gov>, Christopher Latty <christopher_latty@fws.gov>, Angela Matz <angela_matz@fws.gov>, Jennifer Reed <jennifer_reed@fws.gov>, John Trawicki <john_trawicki@fws.gov>, Drew Crane <drew_crane@fws.gov>, Edward Decleva <edward_decleva@fws.gov>, Stephen Arthur <stephen_arthur@fws.gov>, Paul Leonard <paul_leonard@fws.gov>, Eric Taylor <eric_taylor@fws.gov>, Randy Brown <randy_j_brown@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, Greta Burkart <greta_burkart@fws.gov>, Mark Miller <memiller@blm.gov>, Roger Kaye <roger_kaye@fws.gov>, Hollis Twitchell <hollis_twitchell@fws.gov>, Wendy Loya <wendy_loya@fws.gov>
Cc: Stephanie Brady <stephanie_brady@fws.gov>

All

Please find attached the basic reporting template. This has not changed from the initial format.

Additionally, two examples are attached for your consideration and referral in preparing your discipline reports: one biological resource and one physical resource.

These reports due **COB 16 Feb 2018**. Further, they are

not comprehensive and therefore, include only that known information and missing data deemed the highest priorities for moving forward. It should be understood that this is only a precursor to more comprehensive discipline specialty evaluations that will be generated in the future.

Our discussion tomorrow will provide an opportunity to team leads to get and give information and answer any questions.

Thanks to your efforts on this matter

John

--
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Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
101 12th Ave. Room 206
Fairbanks, AK 99701
(907) 456-0450
https://www.fws.gov/refuge/kanuti/

REPORTING TEMPLATE

Discipline/Subject Area: Birds

What do we need to know and why regarding subjects?

The Coastal Plain of the Arctic National Wildlife Refuge (hereafter Refuge) and adjacent marine waters (including the 1002 Area) are recognized as Important Bird Areas by the American Bird Conservancy, Audubon, and Birdlife International. Prior studies have demonstrated the value of the 1002 Area to both breeding and non-breeding birds. During the short Arctic summer, millions of shorebirds, waterfowl, loons, other waterbirds, and landbirds use the 1002 Area. At least 158 species of birds have been recorded on the Refuge Arctic Coastal Plain, and birds that use the Refuge have ranges that include all 50 U.S. states and six continents. Of the 57 species that regularly occur in the 1002 Area, 25 are USFWS Birds of Management Concern, 14 are USFWS Alaska Region Priority Species, and 11 are listed as Near Threatened or Vulnerable by the International Union for Conservation of Nature or are on the Audubon Red List. ~~Two species~~Stellar's and spectacled eiders are listed under the provisions of the Endangered Species Act and have been reported in the 1002 Area, although only spectacled eiders ~~are known currently~~ reside and breed there currently.

The first three purposes of the Refuge, as established by the Alaska National Interest Lands Conservation Act are:

- "to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to…snow geese, peregrine falcons and other migratory birds";
- "to fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats";
- "to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents";

Applicable international treaties include the Migratory Bird Treaty. Other authorities under which we manage and conserve birds on Refuge include the Endangered Species Act, the Bald and Golden Eagle Protection Act, and the Refuge Administration Act of 1966 as amended by the Refuge Improvement Act of 1997.

Conservation of birds in association with exploration, development, and production of oil and gas resources in the 1002 Area of the Coastal Plain of the Refuge will require information regarding:

- Contemporary abundance and distribution of breeding and non-breeding birds in the 1002 Area, with particular attention to identification of important nesting, feeding, and molting areas;
- Phenology and patterns of seasonal movement by breeding and non-breeding birds in the 1002 Area;
- Impacts of development and disturbance to birds using the 1002 Area (including pre-development baseline data) during sensitive time periods, with special consideration given to how the dissimilarities in water availability between the 1002 Area and areas like Prudhoe Bay and National Petroleum Reserve – Alaska (NPR-A) may lead to differential impacts; and

What information is available to address information needs and what are the remaining gaps?

1. Resource Inventories

Bird abundance and distribution information for the 1002 Area will help define the areas that are most important for species, or groups of species, and can therefore help define conservation and management priorities.

1.1 Historical surveys for breeding and non-breeding birds

Surveys in the late 1970s through mid-1980s in the 1002 Area included site-specific ground-based tundra breeding bird surveys on the coast and inland, breeding- and post-breeding bird surveys on barrier islands and lagoons, aerial breeding swan surveys, aerial- and ground-based breeding raptor surveys, and post-breeding snow goose surveys. Although these data provide important historical information about the bird resources of the 1002 Area, abundance and distribution for many species has likely changed as it has on the broader Alaska Coastal Plain over the intervening 40 years.

1.2 Recent surveys of breeding birds

- Ground-based surveys of breeding shorebirds were conducted throughout the 1002 Area in summers 2002 and 2004. That work found higher shorebird density in wetlands and near the Canning River Delta. Although surveys were informative, some species were encountered in low numbers making distribution and abundance estimates unreliable.
- Aerial surveys of waterbirds, including waterfowl, loons, and gulls, have been conducted annually across much of the Alaska Coastal Plain since the mid-1980s. However, only about 1/4th of the 1002 Area is included, and what is surveyed is done so at the lowest intensity, making estimates of waterbird abundance and distribution for the 1002 Area unreliable.
- Aerial breeding bird surveys (primarily for common eiders) were conducted on barrier islands in summer 1999-2009. Ground-based surveys were conducted in summer 2003/04 and 2014-17. Aerial survey estimates were variable between years. Ground surveys revealed breeding common eider abundance on the barrier islands increased by over 25-fold between 1976 and 2015.
- Breeding cliff-nesting raptors were periodically surveyed in the Brooks Range, foothills, and 1002 area in the 1990s and early 2000s. Overall abundance of nesting raptors ~~nests~~ was generally low in the 1002 Area, but breeding raptor populations fluctuate significantly between years.

1.2.1 Site-specific surveys of breeding birds

The Canning River is the only site that has on-going, fine spatial scale breeding bird data within the 1002 Area. Intensive surveys focused on shorebird breeding abundance were conducted semi-regularly between 1979 and 2011. Some waterbird and passerine abundance data were also collected. This site has provided significant information on habitat use patterns and variation in the phenology of tundra nesting shorebirds, passerines, waterfowl, and loons. The long-term data collected at the site also ~~has provided~~ provides information on trends in abundance for some of the more common bird species breeding in the 1002 Area, including an apparent 20-fold increase in cackling geese since 1980.

1.3 Recent Surveys of non-breeding birds

- Boat- and ground-based coastal shorebird surveys were conducted during fall staging and migration at the major river deltas, 2006-2011. These investigations found the vast majority of shorebirds using the surveyed deltas were juveniles.
- Aerial fall-staging snow geese surveys occurred in the 1990s and early 2000s. Up to 325,000 snow geese were estimated to use the Refuge Coastal Plain in some years.
- Lagoon and near-shore surveys of post-breeding and molting waterbirds were conducted during fall 2002-2003. Up to 20, 28, 29, 33, and 41% of the yellow-billed loons, red-throated loons, long-tailed

ducks, scaup, and pacific loons, respectively, counted during the entire Alaska Coastal Plain survey occurred along the Refuge coast.

- Adults of three species of shorebirds were tagged at four sites on the ACP (including two species at one site in the 1002 Area) with GPS loggers to document use of stopover sites along the Beaufort Sea coast in summer 2017, but tagging of more individuals and species is needed before assessments can be completed.

1.4 Resource inventory gaps for breeding and non-breeding birds

Most of the current information on bird abundance and distribution in the 1002 Area was collected for only one or two years, covers only a small portion of the 1002 Area, and/or was collected at very low survey intensity. In addition, the 1002 Area contains far fewer waterbodies compared to sites further west (e.g., within NPR-A), therefore birds are likely more patchily distributed which reduces the ability to apply existing surveys ~~to the broader~~from across the Arctic Coastal Plain to the 1002 Area. Contemporary information on bird abundance and distribution patterns in the 1002 Area are needed, especially considering that many shorebirds (either at the species or sub-species level) are declining, some goose species are increasing broadly across the North American Arctic, and habitats are changing across the Arctic Coastal Plain due to warmer, long summers.

2. Phenology

The timing of key life events (phenology) is a critical part of nearly every important ecological relationship. For birds, the phenology of arrival, nesting, brood-rearing, and staging prior to migration likely coincides with availability of critical food and other resources. Understanding bird phenology in the 1002 Area may allow exploration and development activities to occur during periods when birds are less reliant on specific areas and habitats.

2.1 Status of phenology information for 1002 Area birds

- A large amount of information on the timing of breeding is available for tundra-nesting birds from across the Alaska Coastal Plain, and ~~can~~ may be reasonably ~~be~~ extrapolated to the 1002 Area.
- Phenological data are available for juvenile shorebirds using 1002 Area river deltas in the late summer and fall, although substantial differences in the timing among sites was detected.
- Some phenology information are available for molting sea ducks and waterbirds using coastal lagoons from studies in the 1980s, but surveys were generally only conducted a few times across several months, therefore the range in timing of peak use is not known.
- Reasonably good information is available on the phenology of snow geese using tundra areas during fall staging from studies conducted through the early 2000s.
- In addition to surveys, waterbird telemetry studies from sites further to the west on the Alaska Coastal Plain may be applicable to the phenology of these species in Refuge lagoons.
- Raptor phenology is fragmented and limited to observations of birds on nests during surveys along major rivers during the 1990s and early 2000s.
- Adults of a few shorebirds species were tagged in summer 2017 with GPS loggers and transmitters. These devices will provide phenology data during the post-breeding season.

2.2 Information gaps for bird phenology

- In general there is good information from previous studies within and adjacent to the 1002 area for the phenology of breeding birds and post-breeding snow geese and juvenile shorebirds along the deltas, but a comprehensive survey plan is appropriate to assess impacts of energy development.

- Information on golden eagle and other raptor phenology is poor for the 1002 Area. Because these species may occur on the coastal plain in late winter when seismic activity occurs, they may be impacted by exploration.
- Although surveys have demonstrated the importance of the Refuge lagoons for waterbirds, we have a poor understanding of the phenology of this habitat. In addition, climate-mediated changes to the Beaufort Sea nearshore areas may be affecting benthic prey communities and therefore the timing of when birds use the lagoons could be affected.
- Post-breeding phenology of adult~~s~~ shorebirds is poorly understood, and so far, few have been fitted with tracking devices that provide movement data along the Beaufort Sea coast.
- The amount time birds remain at key stopover sites is virtually unknown for most birds using the 1002 Area. These data are important for calculating disturbance or displacement risk and determining seasonal abundance estimates.

3. Potential impacts of development and disturbance

Oil and gas development may impact breeding and post-breeding birds through building and line strikes, loss or alteration of habitat, increased predator abundance, disturbance, and contamination.

<u>3.1 Knowledge on impacts of oil and gas development</u>

Numerous studies have been conducted on the impacts of development and disturbance to nesting and non-breeding birds at Prudhoe Bay and in NPR-A since the 1970s. Additionally, several studies on the potential impacts of industrialization (e.g., enhanced predator numbers) and disturbance to birds were conducted in the 1002 Area. These studies advanced our understanding of potential impacts, but were often limited in scope and consequently provided incomplete insights to complex ecological and management questions. Results of some projects focused on impacts can be found in summary documents, including the Refuge Coastal Plain Resource Assessments and Updates (e.g., Garner and Reynolds 1986, Garner and Reynolds 1987), Refuge Coastal Plain Terrestrial Wildlife Research Summaries (Douglas et al. 2002, Pearce et al. 2018), and the National Research Council report on the cumulative environmental effects of oil and gas activities on Alaska's North Slope (National Research Council 2003).

<u>3.2 Information gaps for potential impacts of development and disturbance</u>

- Before an assessment of potential impacts of development can be conducted, better information on abundance, distribution, habitat use, and phenology of breeding and non-breeding birds in the 1002 Area is required. Therefore, the topics below only address the most apparent immediate needs.
- The extent to which wetlands will be lost due to water ~~needs~~ use for oil and gas development needs to be better understood to evaluate impacts on birds. Exploration and development activities generally require substantial volumes of freshwater, but the 1002 Area contains < 1/10 the density of lakes as areas to the west where oil and gas activities are ongoing. Also, 1002 Area lakes tend to be shallower and freeze to the bottom during winter. Therefore, wetlands and waterbodies, especially where clustered, are a precious commodity to the birds inhabiting the 1002 Area. Because of this, activities that affect the availability, seasonality, or flow of water could have different effects on birds, their habitats, and their foods in the 1002 Area compared to areas further to the west, but how and to what extent is unknown.
- Little is known about the contemporary predator community or abundance in the 1002 Area. Changes in the avian predator community makeup, predator abundance, and impact to avian productivity have been some of the most commonly described consequences of industrial activity for birds breeding on the Alaska Coastal Plain. Because red fox are thought to take advantage of anthropogenic corridors and Arctic fox have been found to change winter range in response to

human activity, gathering baseline data on predator abundance, distribution, range, and prey preferences in the 1002 Area should occur as soon as possible, preferably before exploration occurs. Little contemporary baseline exposure data are available for contaminants related to oil and gas development and activities for birds in the 1002 Area.

What studies/surveys need to be conducted to fill ~~those~~ information gaps? (order represents approximate ranking of prioritization)

- Conduct ground or aerial surveys of Brooks Range, foothills, and Coastal Plain rivers for cliff-nesting raptor nests. Because raptors may begin using the Coastal Plain while winter exploration activities occur, these surveys/studies should begin as soon as possible.
- Conduct aerial- or ground-based inventories of breeding birds. Species groups should include waterfowl, loons, gulls, shorebirds, and landbirds and should also include both area-wide and site-specific surveys. This data will provide contemporary information on distribution and abundance and help identify important areas for birds. Prioritization of surveys should be based on conservation needs. Because this information may be important to leasing, and because year-to-year variability will require baseline data to be collected over several years, surveys should begin as soon as possible.
- Conduct surveys to estimate abundance and distribution of predators of birds and eggs. Additional studies should also be conducted to determine current depredation rates of the more common or sensitive species, and gather baseline information on movement patterns of foxes in the 1002 Area. Because year-to-year variability will require baseline data to be collected over several years, surveys should begin as soon as practical.
- Determine post-breeding abundance, distribution, habitat use, and phenology of lagoons by waterfowl and loons and deltas and coastal areas by adult shorebirds. Prioritization should be based on species conservation need and potential impact of development.
- Investigate how differences in water availability and patchiness of water between the 1002 Area and Prudhoe Bay and NPR-A may affect how bird impact studies done ~~in~~ at those other sites can be translated to the 1002 Area.
- Conduct studies on the foraging ecology of nest predators and how individuals choose food items and adjust diet patterns based on alternative prey. Objectives should target ways to inform potential management actions if local predator abundance is found to increase post-human activities.
- Update baseline contaminant exposure information for birds breeding in the 1002 Area and using deltas and lagoons for fall staging, with particular emphasis on hydrocarbon exposure and how contaminant burdens may affect subsistence value.
- The above studies should incorporate and address potential impacts from climate change to birds in the 1002 Area.
- The above studies should incorporate how predators and birds adjacent to the 1002 Area may change their behavior in response to activities directly related to 1002 Area oil and gas development.
- Much of the data from surveys and studies conducted in the 1002 Area are not widely available. The Refuge is working with FWS Science Applications to build a publically accessible database for the long-term dataset for the Canning River Delta tundra nesting bird project. Comparable efforts should follow for other projects to ensure appropriate storage and management of important data and allow for public data access to both contemporary and historic data. Furthermore, data management strategies should be developed prior to future data collection in the 1002 Area to ensure no data are left behind in this effort.

Douglas, D., P. Reynolds, and E. Rhode. 2002. Refuge Coastal Plain Terrestrial Wildlife Research Summaries. U.S. Geological Survey, Biological Resources Division.
Garner, G. W., and P. E. Reynolds. 1987. 1985 Update Report Baseline Study of the Fish, Wildlife, and their Habitats. U.S. Fish and Wildlife Service, Anchorage, AK.
Garner, G. W., and P. F. Reynolds. 1986. Refuge Coastal Plain resource assessment. Final report, baseline study of the fish, wildlife, and their habitats. US Department of the Interior, U.S. Fish and Wildlife Service.
National Research Council. 2003. Cumulative environmental effects of oil and gas activities on Alaska's North Slope. The National Academies Press,, Washington, DC.
Pearce, J. M., P. L. Flint, T. C. Atwood, D. C. Douglas, L. G. Adams, H. E. Johnson, S. M. Arthur, and C. J. Latty. 2018. Summary of wildlife-related research on the Coastal Plain of the Refuge, Alaska, 2002–17. 2331-1258, US Geological Survey.

From:	Churchwell, Roy
To:	Berendzen, Steve
Cc:	Hollis Twitchell; Christopher Latty; Jorgenson, Janet; Roger Kaye; Joanna Fox; Reed, Jennifer; Stephen Arthur; Greta Burkart
Subject:	Re: Arctic Leasing Workshop
Date:	Friday, February 16, 2018 11:15:04 AM

Hello Everyone,

Earlier in the week I told Joanna that I would set up the Refuge's Conference Room with the presentation. So, I will plan to do that and watch it from here at USFWS just in case some folks were counting on that.

Roy

On Fri, Feb 16, 2018 at 8:35 AM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:

> For those who can attend the seismic workshop in person this morning, Shelly responded that it will be in the BLM Arctic Conference room at their office building. I hope many of you can attend this.
>
> Steve Berendzen
> Acting Manager, Arctic National Wildlife Refuge
> 907-456-0253
>
> ---------- Forwarded message ----------
> From: **Jones, Nichelle (Shelly)** <njones@blm.gov>
> Date: Fri, Feb 16, 2018 at 8:25 AM
> Subject: Re: Arctic Leasing Workshop
> To: "Berendzen, Steve" <steve_berendzen@fws.gov>
>
> We will be in our Arctic Conference Room at our BLM office on the corner of Airport and University Ave. Happy to have folks come over and join us here.
>
> Shelly Jones
> Acting Manager
> Arctic District Office
> 222 University Avenue
> Fairbanks, AK 99709
>
> (907) 474-2310 (w)
> (907) 460-0086 (c)
>
> On Thu, Feb 15, 2018 at 10:24 PM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:
>
>> Shelly,
>>
>> Can you tell me where you will be hosting the Oil & Gas 2-hour workshop tomorrow (Friday). I think some of our Arctic staff would like to attend in person, and I'll forward to them so they can hopefully do that.
>>
>> Steve Berendzen
>> Acting Manager, Arctic National Wildlife Refuge

907-456-0253

On Thu, Jan 18, 2018 at 9:02 AM, Nichelle (Shelly) Jones <njones@blm.gov> wrote:

Hello Joanna and Steve:

I am currently on a detail as the BLM Arctic District Manager for the next few months. I know Joanna from our previous work related to the AIVC in Coldfoot. I believe I also met Steve during one of my Dalton Highway trips, so you may remember me from that brief introduction.

There seem to be numerous meetings going on at every level in our organizations right now related to the oil and gas development directed in the Tax Act. I have started attending the interagency coordination calls initiated by FWS.

I wasn't sure if you were already aware of the upcoming workshop on oil and gas leasing that will be happening this Friday (1/19) at the federal building in Anchorage. Since I am in Anchorage this week, I will be attending in person. It looks like it will be a good opportunity to learn some of the basics about oil and gas activities and ask questions related to the way BLM currently manages the planning and permitting during the different phases development.

I will be out of the office next week, but will try to give you a call the week of 1/30 to follow up and pass along any information I have that might be of interest to you from the meeting in case you are not able to attend.

Please know that we hold the USFWS staff, your resources and mission in high regard and will be working hard to make sure that things move forward in the most professional and respectful way possible.

Kind regards,

-Shelly

Shelly Jones
Acting Arctic District Manager, BLM
222 University Ave
Fairbanks, AK 99709
(907) 474-2310

Begin forwarded message:

From: Serena Sweet <ssweet@blm.gov>
To: "njones@blm.gov" <njones@blm.gov>, "scohn@blm.gov" <scohn@blm.gov>, "sfritz@blm.gov" <sfritz@blm.gov>, "dwixon@blm.gov" <dwixon@blm.gov>, "czimmerman@usgs.gov" <czimmerman@usgs.gov>, "ryan_noel@fws.gov" <ryan_noel@fws.gov>, "mary_colligan@fws.gov" <mary_colligan@fws.gov>, "dmushovi@blm.gov" <dmushovi@blm.gov>, "stephen_wackowski@ios.doi.gov" <stephen_wackowski@ios.doi.gov>, "mdraper@blm.gov" <mdraper@blm.gov>, "t75murph@blm.gov"

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Subject: Arctic Leasing Workshop

This event has been changed.

Title: Arctic Leasing Workshop
Call-in number: [redacted] (Passcode: [redacted])

Webex:
[redacted]
Meeting Number: [redacted]
Meeting Passcode: [redacted] (changed)
When: Fri Jan 19, 2018 9am – 3pm Alaska Time
Where: Federal Building, Executive Dining Room, BLM-AK SO Bridge 2
[redacted] Passcode [redacted] (changed)
Calendar: njones@blm.gov
Who:

* ssweet@blm.gov - organizer
* scohn@blm.gov
* sfritz@blm.gov
* dwixon@blm.gov
* czimmerman@usgs.gov
* ryan_noel@fws.gov
* mary_colligan@fws.gov
* dmushovi@blm.gov
* stephen_wackowski@ios.doi.gov
* mdraper@blm.gov
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Event details:
b5-CIP
[redacted]

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Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
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(907) 456-0450
https://www.fws.gov/refuge/kanuti/

From:	Miller, Mark
To:	Twitchell, Hollis
Subject:	Re: Draft Subsistence Resource Assessment -FWS
Date:	Friday, February 16, 2018 11:38:20 AM

Hollis - I don't see your addition / edit in the Google Docs version of the acoustic assessment. Did you do the edit in the MS Word version? If so, please send it to me.

tks

~~~~~~

Mark E. Miller, PhD | Deputy Director
North Slope Science Initiative | http://www NorthSlopeScience.org
Email: memiller@blm.gov | Office: 907-271-3212 | Mobile: 907-231-9427
c/o Bureau of Land Management | Alaska State Office | State Director's Office
222 West 7th Avenue, #13 | Anchorage, AK 99513

~~~~~~

"We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely."
-- E. O. Wilson, *Consilience*

On Thu, Feb 15, 2018 at 3:00 PM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:

> Stacey and Dan, I see you both are on the BLM Interagency Team for Subsistence. Attached is my draft Subsistence Resource Assessment. Any thoughts and/or comments. I will be submitting my final Assessment tomorrow. Mark, thank you for sending me you assessment for acoustic environment, I only added one bullet item regarding noise impacts to subsistence use.
>
> --
> Hollis Twitchell
> Assistant Manager
> Arctic Refuge
> 907 456-0512 w
> 907 378-5732 c

From: Martin, John
To: Twitchell, Hollis
Cc: Wendy Loya; John Trawicki
Subject: Re: Subsistence Assessment
Date: Tuesday, February 20, 2018 8:25:02 AM

Hollis

Got your report and have relocated into the file created by Wendy - Refuges Common Drive. She has the final word on document storage and curation at this time.

Thanks

John

On Fri, Feb 16, 2018 at 2:32 PM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:

> Sent the 1002 Subsistence Assessment to the to your Google Drive folder, but, I didn't see a separate Subsistence Resource Folder in the in the Assessment Drive folder. Anyhow, here it is.
>
> --
> Hollis Twitchell
> Assistant Manager
> Arctic Refuge
> 907 456-0512 w
> 907 378-5732 c

From:	Arthur, Stephen
To:	Janet Jorgenson; Christopher Latty; Burkart, Greta; Churchwell, Roy
Subject:	1002 planning
Date:	Wednesday, February 21, 2018 12:50:57 PM
Attachments:	NPRA maps.pdf

Bio team:

It seems likely that the next steps in the 1002 planning process will be to identify specific geographic areas within the 1002 that deserve special management consideration. This is based on the assumption that BLM will likely follow the same strategy they used in NPRA when they develop the EIS for future work in the 1002. Unfortunately, we are somewhat behind the curve on this (BLM has been working on the NPRA issue for 20+ years). So Joanna and Steve have asked that we biologists put our heads together and start the process of identifying areas with particular value to biological resources (see attached maps of the NPRA to illustrate what I'm talking about). This is somewhat different than our recent task to identify information needs (although this exercise is likely to reveal some info needs) in that we need to be pragmatic: based on what we know now, what do we think are the "most" important or sensitive areas, why, and what management restrictions would be appropriate (such as: limits on type of development, seasonal closures, design requirements, etc.) Again, look at the EIS for NPRA for guidance (Wendy sent a table summarizing these this morning, and the full ROD is located on the Google Drive that John Martin set up).

I think we need to be working toward an actual map showing the value of different parts of the 1002 to wildlife (i.e., identify nesting areas for shorebirds, staging areas for geese, denning habitat for bears, calving and insect relief habitat for caribou, winter habitat for moose, etc.) I have no doubt that in doing this we will find many areas where we need more information, this should be a good illustration of just where those immediate data gaps exist.

I propose that we each take a stab at creating such a map for our respective disciplines (Janet: vegetation, Chris: birds, Me: mammals, Greta: aquatics, Roy: help with any or all of those). We can then circulate the maps among ourselves, and plan a group meeting to discuss them.

Time is short, so I propose we try to have at least a first shot at this done by the end of next week (Friday March 2). Of course, sooner would be better.

At this point, I think it is acceptable to indicate areas that you suspect could be important, but where we don't have data to confirm that. But do indicate your level of uncertainty for those areas.

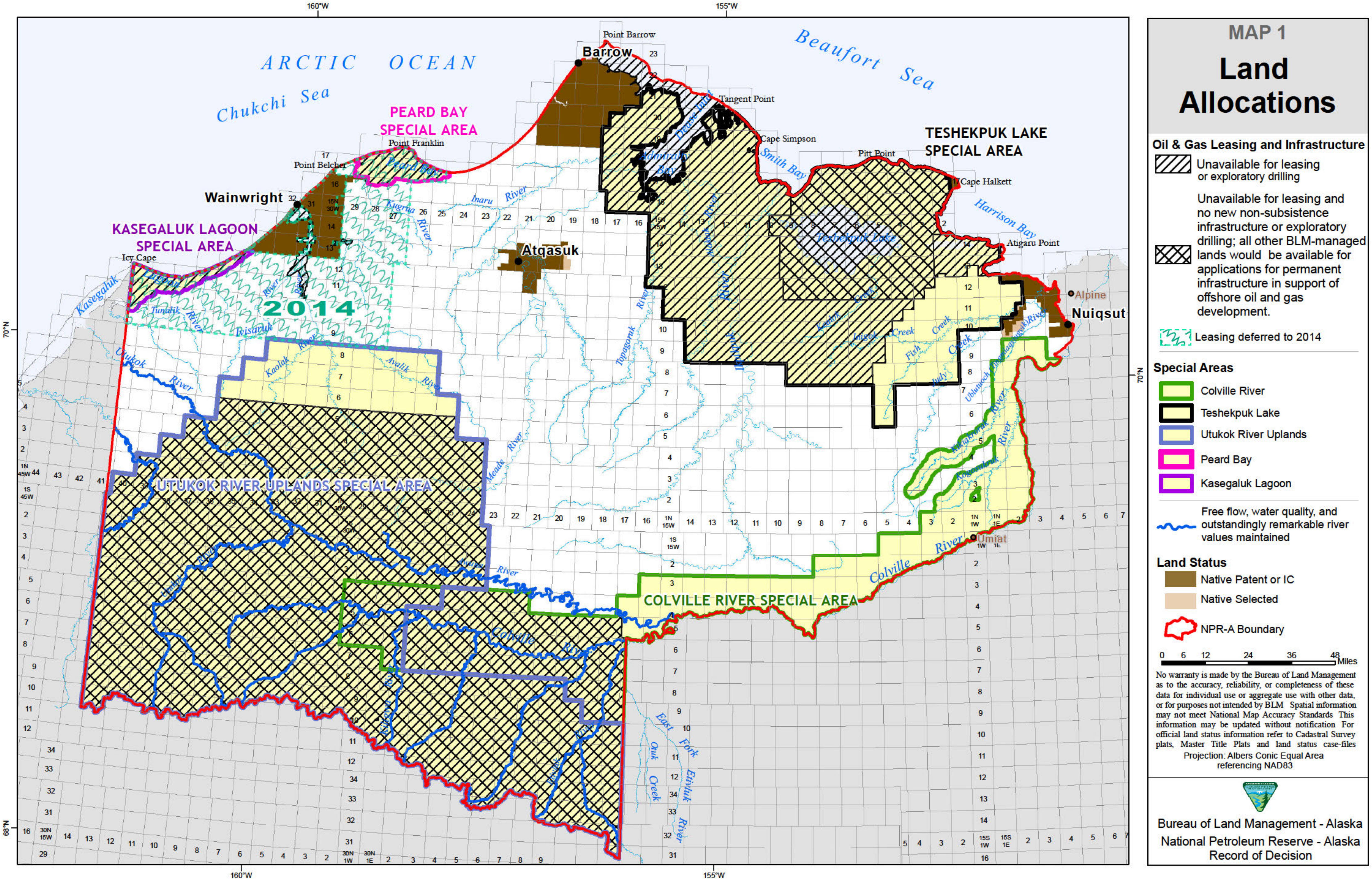
GIS-based maps would be best, but if you prefer to work with paper and pencil, that's fine at this point, just scan and distribute your ideas.

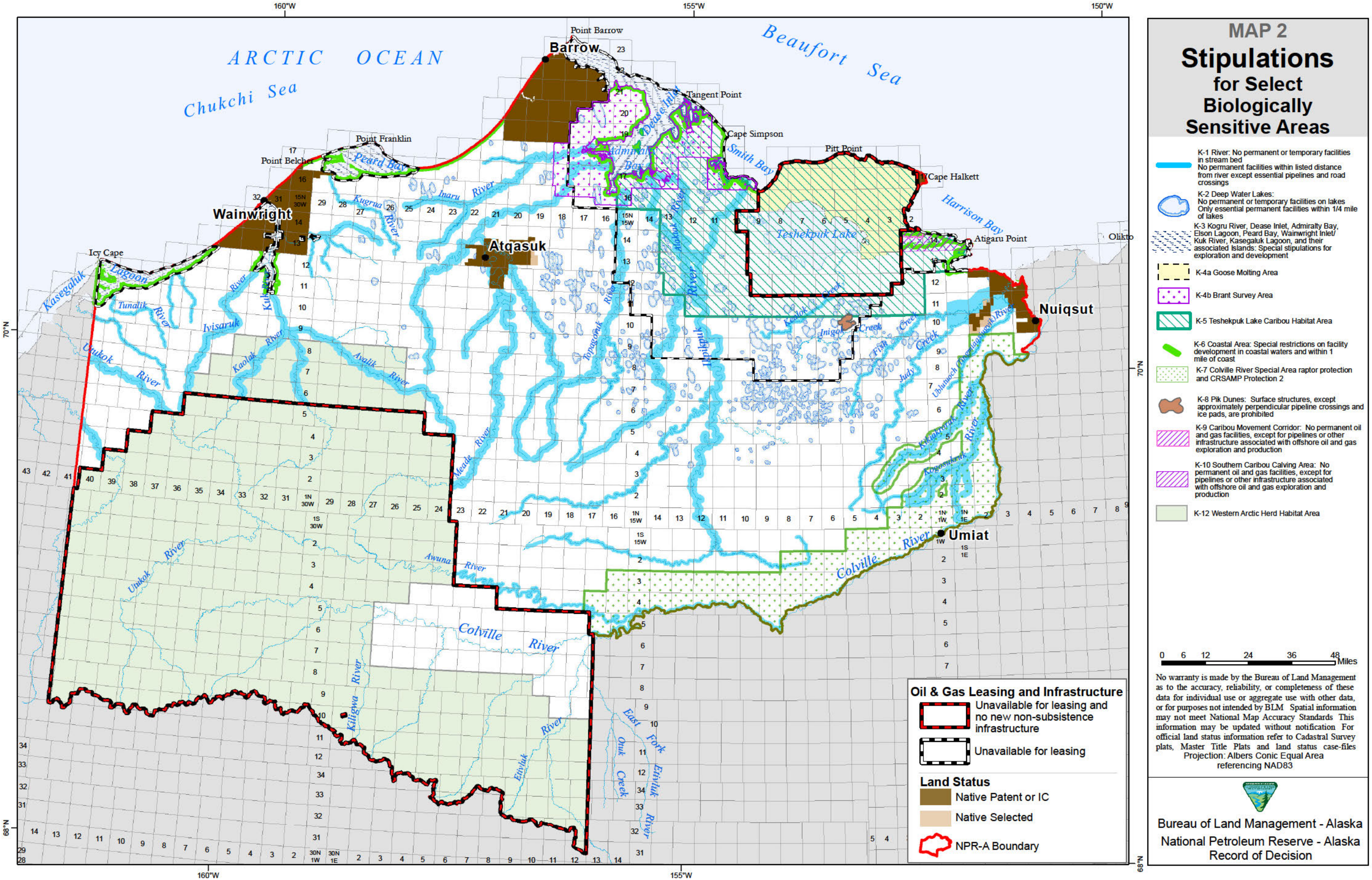
Let me know if you want to discuss this further.

Steve

Stephen M. Arthur, Ph.D.
Supervisory Wildlife Biologist
Arctic National Wildlife Refuge
101 12th Ave., Room 236

Fairbanks, AK 99701
(907)455-1830


MAP 1
Land Allocations
Oil & Gas Leasing and Infrastructure
Unavailable for leasing or exploratory drilling
Unavailable for leasing and no new non-subsistence infrastructure or exploratory drilling; all other BLM-managed lands would be available for applications for permanent infrastructure in support of offshore oil and gas development.
Leasing deferred to 2014
Special Areas
Colville River
Teshekpuk Lake
Utukok River Uplands
Peard Bay
Kasegaluk Lagoon
Free flow, water quality, and outstandingly remarkable river values maintained
Land Status
Native Patent or IC
Native Selected
NPR-A Boundary
0 6 12 24 36 48 Miles
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data, or for purposes not intended by BLM. Spatial information may not meet National Map Accuracy Standards. This information may be updated without notification. For official land status information refer to Cadastral Survey plats, Master Title Plats and land status case-files.
Projection: Albers Conic Equal Area referencing NAD83
Bureau of Land Management - Alaska
National Petroleum Reserve - Alaska
Record of Decision
ARCTIC OCEAN
Chukchi Sea
Beaufort Sea
PEARD BAY SPECIAL AREA
KASEGALUK LAGOON SPECIAL AREA
TESHEKPUK LAKE SPECIAL AREA
UTUKOK RIVER UPLANDS SPECIAL AREA
COLVILLE RIVER SPECIAL AREA
2014
Point Barrow
Barrow
Tangent Point
Cape Simpson
Pitt Point
Cape Halkett
Atigaru Point
Point Franklin
Point Belcher
Wainwright
Icy Cape
Atqasuk
Alpine
Nuiqsut
Umiat
Teshekpuk Lake
Smith Bay
Harrison Bay
Admiralty Bay
Utukok River
Colville River
Meade River
Inaru River
160°W
155°W
70°N
68°N


MAP 2
Stipulations for Select Biologically Sensitive Areas
K-1 River: No permanent or temporary facilities in stream bed
No permanent facilities within listed distance from river except essential pipelines and road crossings
K-2 Deep Water Lakes:
No permanent or temporary facilities on lakes
Only essential permanent facilities within 1/4 mile of lakes
K-3 Kogru River, Dease Inlet, Admiralty Bay, Elson Lagoon, Peard Bay, Wainwright Inlet/ Kuk River, Kasegaluk Lagoon, and their associated Islands: Special stipulations for exploration and development
K-4a Goose Molting Area
K-4b Brant Survey Area
K-5 Teshekpuk Lake Caribou Habitat Area
K-6 Coastal Area: Special restrictions on facility development in coastal waters and within 1 mile of coast
K-7 Colville River Special Area raptor protection and CRSAMP Protection 2
K-8 Pik Dunes: Surface structures, except approximately perpendicular pipeline crossings and ice pads, are prohibited
K-9 Caribou Movement Corridor: No permanent oil and gas facilities, except for pipelines or other infrastructure associated with offshore oil and gas exploration and production
K-10 Southern Caribou Calving Area: No permanent oil and gas facilities, except for pipelines or other infrastructure associated with offshore oil and gas exploration and production
K-12 Western Arctic Herd Habitat Area
0 6 12 24 36 48 Miles
No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data, or for purposes not intended by BLM. Spatial information may not meet National Map Accuracy Standards. This information may be updated without notification. For official land status information refer to Cadastral Survey plats, Master Title Plats and land status case-files.
Projection: Albers Conic Equal Area referencing NAD83
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Land Status
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NPR-A Boundary
ARCTIC OCEAN
Chukchi Sea
Beaufort Sea
Point Barrow
Barrow
Tangent Point
Cape Simpson
Pitt Point
Cape Halkett
Harrison Bay
Atigaru Point
Oliktok
Point Franklin
Point Belcher
Wainwright
Icy Cape
Atqasuk
Nuiqsut
Umiat
Peard Bay
Dease Inlet
Admiralty Bay
Smith Bay
Teshekpuk Lake
Kasegaluk Lagoon
Colville River
Meade River
Utukok River
Kaolak River
Avalik River
Ikpikpuk River
Topagoruk River
Awuna River
Killigwa River
Inigok Creek
Fish Creek
Judy Creek
Kogosukruk River
Kikiakrorak River
Ublutuoch River
Kuk River
Ivisaruk River
Tunalik River
Kugrua River
Inaru River
Etivluk River
East Fork Etivluk River
Otuk Creek
160°W
155°W
150°W
70°N
68°N

From:	Wendy Loya
To:	Christopher Latty; Roy Churchwell; Eric Taylor; Richard Lanctot; Paul Leonard; Ted Swem
Subject:	FW: 1002 resource information assessment for Acoustic Environment
Date:	Wednesday, February 21, 2018 1:14:23 PM
Attachments:	Ortega 2012 Chapter 2 - Effects of noise pollution on birds - a brief review of our knowledge.pdf Francis et al 2012 Noise pollution alters ecological services - enhanced pollination and disrupted seed dispersal.pdf Francis and Blickley 2012 Chapter 1 Introduction - Research and perspectives on the study of anthropogenic noise and birds.pdf Francis 2015 Vocal traits and diet explain avian sensitivities to anthropogenic noise.pdf Kleist etal_noise disrupts GC signaling_PNAS_18.pdf

Hello Avian Ecologists and associates,
Please see the attached publications that were just shared in another email stream, particularly the Kleist paper which was recently published in PNAS.

Wendy

Dr. Wendy M. Loya,
Arctic Program Coordinator, Office of Science Applications
US Fish and Wildlife Service
Anchorage, Alaska
907.786.3532 (office)
907.227.2942 (mobile)

From: Betchkal, Davyd [mailto:davyd_betchkal@nps.gov]
Sent: Wednesday, February 21, 2018 11:05 AM
To: Atwood, Todd
Cc: Payer, David; Miller, Mark; Wendy M. Loya, PhD; Miriam (Nicole) Hayes; Alfredo Soto; Roger Kaye; Tracy Fischbach; Kenneth (Alan) Peck; Fritz, Stacey; Goodwin, Randy
Subject: Re: 1002 resource information assessment for Acoustic Environment

Additional work in the same vein.

I found Ortega 2012 very helpful

On Wed, Feb 21, 2018 at 10:58 AM, Atwood, Todd <tatwood@usgs.gov> wrote:
Looks interesting- thanks for the heads-up. I've attached a copy.

On Wed, Feb 21, 2018 at 10:54 AM, Payer, David <david_payer@nps.gov> wrote:
Thanks for your leadership on this effort, Mark! Ironically I just came across this press release. I haven't gotten my hands on the paper itself yet, but if anyone has access to it, please share http://www.pnas.org/content/early/2018/01/03/1709200115.full

-Dave

On Fri, Feb 16, 2018 at 2:01 PM, Miller, Mark <memiller@blm.gov> wrote:
Wendy -

Here's our team's contribution for the Acoustic Environment.

Mark

~~~~~~
Mark E. Miller, PhD | Deputy Director
North Slope Science Initiative | http://www NorthSlopeScience.org
Email: memiller@blm.gov | Office: 907-271-3212 | Mobile: 907-231-9427
c/o Bureau of Land Management | Alaska State Office | State Director's Office
222 West 7th Avenue, #13 | Anchorage, AK 99513
~~~~~~

"We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely."

-- E. O. Wilson, *Consilience*

--

Davyd Betchkal
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Chapter 2: Effects of noise pollution on birds: A brief review of our knowledge - Efectos de la Polución Sonora en Aves: una Breve Revisión de Nuestro Conocimiento
Author(s): Catherine P. Ortega
Source: *Ornithological Monographs*, Vol. 74, No. 1 (July 2012), pp. 6-22
Published by: American Ornithologists' Union
Stable URL: http://www.jstor.org/stable/10.1525/om.2012.74.1.6

Ornithological Monographs
Volume (2012), No. 74, 6–22

CHAPTER 2

EFFECTS OF NOISE POLLUTION ON BIRDS: A BRIEF REVIEW OF OUR KNOWLEDGE

Catherine P. Ortega

Ecosphere Environmental Services, 776 E. Second Avenue, Durango, Colorado 81301, USA

Abstract.—Many avian species have long been exposed to loud natural sounds such as streams, waterfalls, and wind. However, anthropogenic noise pollution is a relatively recent phenomenon that birds now have to cope with throughout much of the world. Early investigations on bird responses to noise tended to focus on physical damage to ears, stress responses, flight or flushing responses, changes in foraging, and other behavioral reactions. These studies were often conducted under laboratory conditions because determining effects of noise on free-ranging birds is particularly difficult, in that we rarely have the opportunity to isolate noise as a single testable variable. By coupling introduced noise on the landscape (e.g., from gas well compressors) with ecologically similar controls, investigators have recently found additional responses, including avoidance of noisy areas, changes in reproductive success, and changes in vocal communication. Numerous investigators have compared urban birds with their rural counterparts in quieter surroundings and found that at least some birds can compensate for the masking effect of noise through shifts in vocal amplitude, song and call frequency, and song component redundancies, as well as temporal shifts to avoid noisy rush-hour traffic. Sounds have presumably always been part of the environment, but noise pollution has escalated over the past century, especially the past few decades, disturbing the integrity of natural ecosystems. This review provides general background information, updates on the most current literature, and suggestions for future research that will enhance our comprehensive knowledge and ability to mitigate negative effects of noise.

Key words: birds, communication, hearing, noise pollution, soundscape.

Efectos de la Polución Sonora en Aves: una Breve Revisión de Nuestro Conocimiento

Resumen.—Muchas especies de aves han sido expuestas prolongadamente a sonidos naturales fuertes, como arroyos, cascadas y viento. Sin embargo, la polución sonora antropogénica es un fenómeno relativamente reciente con el que las aves tienen que lidiar ahora en casi todo el mundo. Las primeras investigaciones sobre la respuesta de las aves al ruido tendían a enfocarse en el daño físico a los oídos, las repuestas de estrés, las respuestas de vuelo o huída, los cambios en el forrajeo y otras reacciones de comportamiento. Estos estudios fueron frecuentemente conducidos bajo condiciones de laboratorio porque determinar los efectos del ruido sobre aves libres es particularmente difícil, ya que rara vez se tiene la oportunidad de aislar el ruido como única variable que se pone a prueba. Al acoplar el ruido introducido en el paisaje, como el de los compresores de pozos de gas, con controles ecológicamente similares, los investigadores recientemente han encontrado respuestas adicionales, incluyendo la evasión de áreas ruidosas, cambios en el éxito reproductivo y cambios en la comunicación vocal. Numerosos investigadores han comparado

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Ornithological Monographs, Number 74, pages 6–22. ISBN: 978-0-943610-93-1. © 2012 by The American Ornithologists' Union. All rights reserved. Please direct all requests for permission to photocopy or reproduce article content through the University of California Press's Rights and Permissions website, http://www.ucpressjournals.com/reprintInfo.asp. DOI: 10.1525/om.2012.74.1.6.

aves urbanas con sus contrapartes rurales que ocupan áreas más silenciosas, y encontraron que al menos algunas aves pueden compensar el efecto de enmascaramiento del ruido por medio de cambios en la amplitud vocal, la frecuencia del canto y los llamados, y las redundancias en los componentes del canto. Las aves también exhiben cambios temporales para evitar el ruido de las horas pico del tráfico. Presumiblemente, los sonidos siempre han sido parte del ambiente, pero la polución sonora ha crecido a lo largo del siglo pasado y especialmente durante las últimas décadas, perturbando la integridad de los ecosistemas naturales. Esta revisión provee información general de base, información de la literatura más reciente y sugerencias para investigación futura que va a mejorar nuestro conocimiento y la habilidad para mitigar los efectos negativos del ruido.

The word *noise* dates back to the 13th century, and its etymology reveals the disdain that humans have long felt for noise. It originates from the Latin word *nausea* and is defined as unwanted sound or sound that interferes with hearing other sounds. *Sound* is typically defined as vibrations that move through the environment (e.g., air, water, or another medium) and provide an auditory sensation. Noise is a subjective perception with intra- and interspecific variation. One person may perceive a symphonic piece as glorious music while another perceives the same piece as disturbing noise. Similarly, important communication for one species may be perceived as noise by another species. For example, a loud chorus of frogs may interfere with the ability of owls to hear their prey, and cicadas (Slabbekoorn and Smith 2002) or colonies of seabirds (Feare et al. 2003) create a "deafening" experience to any other listener. The sounds of nature can be unwanted at times and can interfere with hearing or interpreting other sounds (Coates 2005), but the term "noise pollution" generally refers to unwanted sounds resulting from human activities.

Anthropogenic noise is related to human population density; therefore, we can assume that it has and will continue to increase as human populations increase. Cities have always been noisy (Rosen 1974), but noise pollution has dramatically increased since the industrial revolution. More recent technologies, especially recreational vehicles and modern conveniences, have exacerbated the problem. Although urban and suburban areas are noisier than less developed areas, natural areas are becoming increasingly noisy. No place on Earth is free from noise pollution because aircraft noise penetrates even the most remote locations. Noisy off-highway vehicles have also become common, even in formerly secluded areas (Barton and Holmes 2007).

Although noise has escalated over many decades, published studies on the effects of noise on birds have surged only in the past decade, possibly as a result of new instruments, song analysis programs, and opportunities to control noise. Most of this recent work has occurred in the field of vocal communication, often within the context of evolution of communication. Many papers have reviewed the effects of noise pollution on birds and other wildlife (Larkin et al. 1996, Warren et al. 2006, Dooling and Popper 2007, Slabbekoorn and Bouton 2008, Slabbekoorn and Ripmeester 2008, Brumm and Naguib 2009, Barber et al. 2010), but no recent review has covered the wide range of established and possible effects on birds. Therefore, the purpose of the present review is to (1) provide a general background for those unfamiliar with noise literature, (2) provide an update on the most current literature, and (3) suggest areas in need of future research that will enhance our comprehensive knowledge and ability to mitigate negative effects of noise.

How Sound Moves and Is Measured

Sound travels through air or other media in compression and expansion waves. The intensity of these waves produces a sound pressure level, which can be measured with a sound pressure meter. Sound pressure levels are typically measured over a period of time and expressed as a mean, which is most useful for studies of relatively continuous noise. For studies of intermittent noise, maximum sound levels may provide more meaningful measurements, as might other noise metrics that are reviewed in detail by Pater et al. (2009). The commonly used unit of measurement of sound pressure is the decibel (dB), a logarithmic measurement that can accommodate a wide range of frequencies. To put the dB scale in perspective, in the absence of environmental interference, an increase of 6 dB represents a doubling of loudness.

Not all sound pressures are perceived as equally loud because the ear (human or nonhuman) does not respond to all frequencies equally. For our convenience, we use a filter on sound level meters that respond to frequencies similarly to the human ear

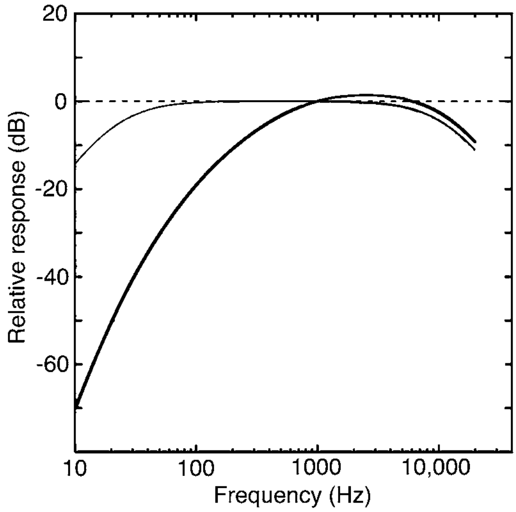

FIG. 1. A (thick line), C (thin line), and flat (black dashed line) decibel weighting systems.

(Fig. 1). This filter provides measurements on the "A scale," weighted for the range of human hearing. It is the most commonly used scale because much of our concern about noise is anthropocentric. In studies of potential effects of noise on nonhuman animals, especially those able to hear low frequencies, the C scale can be useful. For example, compared with humans, doves have ~40 dB more sensitivity at 1–10 Hz (Yodlowski et al. 1977, Kreithen and Quine 1979, Warchol and Dallos 1989, Schermuly and Klinke 1990); therefore, sounds in this range must be louder for us to hear them. The C scale used in conjunction with the A scale is useful to identify low-frequency sound because if the sound pressure levels consistently measure higher on the C scale than on the A scale, the difference might be explained by low-frequency noise. Alternatively, the distribution of acoustic energy can be assessed via analysis of recordings of the sound.

Degradation of sound structure differs with habitat as a result of differences in atmospheric spread, air turbulence, reflections, and scatter through materials such as vegetation (Brumm and Naguib 2009). This occurs through three main mechanisms: attenuation, reverberations, and irregular fluctuations in amplitude (Slabbekoorn et al. 2007). Attenuation is frequency dependent, with lower frequencies (sounds with longer wavelengths) being less affected by small objects (even molecules in the air) than higher frequencies; therefore, higher-frequency sounds usually attenuate faster, and lower frequencies travel farther. Reverberations, or echoes, reflect off surfaces in the environment numerous times and almost always arrive at the receiver later than the original signal, producing a variety of effects (Warren et al. 2006). Irregular fluctuations in amplitude are caused by air turbulence and accumulation of reverberations.

Under conditions without disruption of sound waves, sound levels decrease by 6 dB(A) with every doubling of distance from the sound source (Larkin et al. 1996). Therefore, if the study aims to identify effects of noise on birds, distance of a bird to the sound source must be considered. For a nest study, this involves measuring sound pressure level at the nest. For bird surveys, it requires taking Universal Transverse Mercator coordinates, compass bearing, and distance from the survey location to each bird detected; these values can be used with trigonometric functions to determine distance from each bird to the noise source. However, this method does not consider topography, vegetation, and other conditions that could alter noise attenuation. If it is practical, the investigator can also measure the sound level at the location of a bird after survey completion.

EFFECTS OF NOISE ON BIRDS

Many studies have focused on effects of landscape-scale conversions of visually differentiated habitat, but noise has received far less attention. Larkin et al. (1996:8) noted that

> Like other related fields such as effects of vehicles or recreation on wildlife…, effects of noise on wildlife often appear in the "gray literature" of conference proceedings and unpublished reports and manuscripts, rather than in the refereed scientific literature.

We have come some distance since 1996, but relatively few investigators currently work on this challenging new field of study.

Noise pollution affects birds in myriad ways, including (1) physical damage to ears; (2) stress responses; (3) fright–flight responses; (4) avoidance responses; (5) changes in other behavioral responses, such as foraging; (6) changes in reproductive success; (7) changes in vocal communication; (8) interference with the ability to hear predators and other important sounds; and (9) potential changes in populations. Reactions to noise depend on the type of noise produced, including frequency, loudness, consistency, and

duration. Some species react more negatively to noise than others. Colonial birds are highly susceptible to noise because when one bird reacts, many or all birds in a colony will react similarly (Burger 1998), whether the group responds directly to the noise or to the first bird(s) that responded.

Physical damage to ears.—Exposure to loud sounds damages sensory hair cells. In mammals, this results in permanent hearing loss. However, birds regenerate these hairs to some extent (Niemiec et al. 1994); therefore, damage is more temporary but with species-specific variation in recovery times (Ryals et al. 1999). Niemiec et al. (1994) reported increased recovery time with repeated exposure, which may have important implications for birds exposed to chronic or repeated noise. Physical damage to birds' ears occurs either with short-duration but very loud sounds (>140 dB[A] for single blasts or 125 dB[A] for multiple blasts; e.g., construction noise) or continuous (>72 h) exposure to noise >110 dB(A) (Dooling and Popper 2007). Some Federal agencies set noise standards within buffer zones for nests of high-priority species such as eagles, hawks, and owls; however, little else protects wild animals from noise.

Stress and fright–flight responses.—Chronic stress causes numerous physiological responses, including elevated heart rate, changes in hormone levels, and weight loss. Chronic stress also impairs the ability of birds to resist diseases and reduces their reproductive success (Blickley and Patricelli 2010). Some studies on noise and domesticated and laboratory animals have demonstrated fright–flight, avoidance, and agitation responses to noise (Environmental Protection Agency [EPA] 1980, Bowles 1995), yet these laboratory approaches to studying the effects of noise provide very little insight regarding how natural populations respond to noise. Much of the work conducted on stress and fright–flight responses under natural conditions focused on moving vehicles, such as aircraft (Brown 1990, Conomy et al. 1998, Trimper et al. 1998, Ward et al. 1999, Goudie 2006) and watercraft (Burger 1998, Rodgers and Schwikert 2002), which introduces confounding variables, especially visual disturbance.

Avoidance responses.—Avoidance appears to be the most common response to human disturbance, but some species are surprisingly tolerant and even seek out association with humans and disturbed habitats, including noisy habitats (e.g., House Finch [*Carpodacus mexicanus*] and Black-chinned Hummingbird [*Archilochus alexandri*]; Francis et al. 2009). Anthropogenic noise is almost always associated with other confounding disturbance variables (e.g., visual disturbances, vegetation, food resources, pollutants, concrete or asphalt effects on temperature, and perceived risks), which are difficult, if not impossible, to control.

Even though studies of road traffic noise are severely confounded by other variables, the effects of road-associated variables, including noise, measured by occupancy and densities, are consistently negative for most birds. Brotons and Herrando (2001), Forman and Deblinger (2000), and Fernández-Juricic (2001) found lower occupancy of birds near roads and attributed the lower numbers, in part, to traffic noise. In the Netherlands, Reijnen et al. (1995) controlled for visual aspects of the highway and found that noise was an important variable explaining lower occupancy near major roads. Although roads negatively affect a variety of taxa (Haskell 2000, Brotons and Herrando 2001, Reijnen and Foppen 2006), the overall effect of traffic noise on nesting birds, measured through lack of habitat occupancy, may extend >300 m on both sides of roadways (Forman and Deblinger 2000). From these and similar findings in the Netherlands (Reijnen et al. 1995), Forman (2000) and Forman and Alexander (1998) estimated that one-fifth of the United States is directly affected by traffic noise. Clearly, these studies have demonstrated that fragmentation and its associated variables, including noise, produce environmental and ecological impacts well beyond the edge of the physically altered habitat.

A few studies that controlled for noise as a single testable variable found species-specific avoidance of noisy areas. In New Mexico, Mourning Doves (*Zenaida macroura*) avoided gas-well-compressor noise, and several species nested significantly farther from well pads with noisy compressors than from gas well pads without compressors, including the Gray Flycatcher (*Empidonax wrightii*), Gray Vireo (*Vireo vicinior*), Black-throated Gray Warbler (*Setophaga nigrescens*), and Spotted Towhee (*Pipilo maculatus*) (Francis et al. 2009). During surveys, Western Scrub-Jays (*Aphelocoma californica*) and several other species were detected significantly more often on sites without compressors (Francis et al. 2009, Ortega and Francis 2012). In Canada, Bayne et al. (2008) found avoidance of noisy areas by Red-eyed Vireos (*V. olivaceus*), Yellow-rumped Warblers (*S. coronata*), and White-throated Sparrows (*Zonotrichia albicollis*); furthermore, they found 1.5× greater density of breeding birds near

noiseless energy facilities than near sites with noisy compressors.

Changes in foraging responses.—Results of a few studies have suggested negative effects of noise on foraging behavior. In Florida, Burger and Gochfeld (1998) observed significantly reduced foraging in five species with the presence of people compared with the absence of people, and the percentage of time spent foraging decreased with increased noise made by people. Similarly, but under laboratory conditions, Quinn et al. (2006) observed that Common Chaffinches (*Fringilla coelebs*) experienced reduced foraging with added white noise up to 68 dB(A). Canaday and Rivadeneyra (2001) found that machinery noise from petroleum exploration affected foraging guilds in Ecuador.

Changes in reproductive success.—Noise may affect egg production, incubation, brooding, predators, brood parasites, and abandonment, as well as the ability to find or attract a mate and the ability of parents to hear and respond to begging calls. Any species that regularly experience fright–flight responses (Southern and Southern 1979, Burger 1998) or an inability to attract mates and defend territories (Slabbekoorn and Ripmeester 2008) because of noise likely suffer reproductive loss. For some species, this may result in population declines.

Results of studies designed to determine effects of noise on reproductive success suggest species-specific variation. In Francis et al.'s (2009) study in northwest New Mexico, we found higher nest success near noisy gas well compressors than in quiet control sites because predators and cowbirds avoided noisy sites. However, as previously mentioned, many species avoided noisy areas and did not benefit from the lower level of predators and parasites. Black-chinned Hummingbirds preferred noisy sites, and House Finches often used gas-well-compressor equipment for nest sites where the sound pressure levels reached 85 dB(A) at the nest.

Noise may interfere with the ability to attract mates and maintain pair bonds. For example, in Alberta, Canada, male Ovenbirds (*Seiurus aurocapilla*) near gas well compressors experienced a 15% decrease in mate attraction (Habib et al. 2007). Additionally, Habib et al. (2007) found 18% more inexperienced (first-year) Ovenbirds at noisy compressor sites than at quieter control sites, which suggests that noise reduces the quality of habitat for these birds. Reproductive failure or reduced reproductive success can result in pair-bond degradation. In a laboratory experiment, Swaddle and Page (2007) reported that female Zebra Finches' (*Taeniopygia guttata*) preferences for their pair-bonded males decreased significantly with background noise. They suggested that in areas of high-amplitude environmental noise, birds may develop extra-pair behaviors because of weakened pair bonds.

Barton and Holmes (2007) reported reduced nest success close (<100 m) to trails with noisy off-highway vehicles compared with more distant locations in California. As in Francis et al.'s (2009) study, predators appeared to avoid the noisier sites. Barton and Holmes (2007) found 4× more nest abandonment near trails, whereas abandonment did not differ between noisy treatment sites and control sites in Francis et al.'s (2009) study (C. P. Ortega and C. D. Francis unpubl. data); the difference might be explained by chronic (24 h per day, 7 days per week) noise in the latter study compared with intermittent loud noise in the former. If birds select nest sites with chronic noise, to some degree they accept the conditions and may not abandon their nests in response to the noise. In areas with off-road vehicles, birds may select nest sites during the week when the immediate environment seems quiet compared with weekends, or they may select nest sites before the onset of the recreation season. In these cases, birds may not accept noisy conditions as part of the nest selection process, and this may result in nest abandonment.

Changes in vocal communication.—Across taxa, social relationships rely on communication, and vocal communication dominates much of the first-order contact in birds. Even though background noise can critically impair vocal communication, historically investigators did not focus on noise in studies of animal communication (Brumm and Slabbekoorn 2005). Over the past decade, many ornithological studies have focused on the effect of noise on communication.

Although we have a good understanding of a few species-specific responses—for example, in the Domestic Fowl (*Gallus gallus domesticus*; Brumm et al. 2009), Little Greenbul (*Andropadus virens*; Slabbekoorn and Smith 2002), Gray Flycatcher (*E. wrightii*) and Ash-throated Flycatcher (*Myiarchus cinerascens*; Francis et al. 2011), Great Tit (*Parus major*; Slabbekoorn and Peet 2003, Slabbekoorn and den Boer-Visser 2006, Pohl et al. 2009), Gray Shrike-thrush (*Colluricincla harmonica*; Parris and Schneider 2009), Gray Fantail (*Rhipidura*

fuliginosa; Parris and Schneider 2009), Common Nightingale (*Luscinia megarhynchos*; Brumm and Todt 2002; Brumm 2004, 2006), Eurasian Blackbird (*Turdus merula*; Nemeth and Brumm 2009, Ripmeester et al. 2010), Common Chaffinch (Brumm and Slater 2006), Song Sparrow (*Melospiza melodia*; Wood and Yezerinac 2006), Dark-eyed Junco (*Junco hyemalis*; Slabbekoorn et al. 2007), and House Finch (Badyaev et al. 2008)—we still have a great deal to learn about the responses of most species. However, many investigators have laid the groundwork for additional studies of noise.

Numerous studies have shown that environmental conditions constrain sound transmission. Vegetation affects the way that sound moves through different habitats (Ryan 1986, Slabbekoorn and Smith 2002, Hansen et al. 2005, Boncoraglio and Saino 2007, Simons et al. 2007, Pacifici et al. 2008) and different topographic environments (Brumm 2004, Warren et al. 2006, Slabbekoorn et al. 2007). Natural sounds (e.g., insect and other animal vocalizations, rain, wind, streams, and thunder) and anthropogenic noise can interfere with the detection and discrimination of vocal signals (often referred to as "masking"). Therefore, both natural sounds and anthropogenic noise play an essential role in determining the efficacy of vocal communication and also exert a selective pressure on the evolution of communication, often resulting in song frequencies that transmit most efficiently through a given environment (Morton 1975, Ryan and Brenowitz 1985).

Sound transmission differs with habitat (Slabbekoorn and Smith 2002, Slabbekoorn et al. 2007), but at least some birds compensate for these differences. For example, Slabbekoorn and Smith (2002) reported that song frequency of the Little Greenbul varies across habitat gradient in African rainforests. On an evolutionary scale, urban habitat is relatively novel, but some investigators pointed out that some urban settings are acoustically similar to cliffs, canyons, and other natural environments (Brumm 2004, Warren et al. 2006, Slabbekoorn et al. 2007). However, canyons and cliffs do not exist throughout all landscapes; therefore, many species are not adapted for the acoustics of canyons and cliffs. Furthermore, canyons and cliffs have not been well studied as selection pressures for communication in birds. Because urban areas are expanding on a global basis (Slabbekoorn et al. 2007), anthropogenic noise exerts an evolutionarily novel pressure on many birds worldwide.

In addition to environmental conditions, other selective pressures and constraints, such as body size (Morton 1975), vocal apparatus size (e.g., syrinx and bill characteristics; Ryan and Brenowitz 1985, Badyaev et al. 2008), and phylogeny (Ryan and Brenowitz 1985), influence evolution of bird song, with a trend of lower frequencies produced by larger birds (Ryan and Brenowitz 1985). When environmental conditions change, including background noise levels, natural selection will favor vocalizations that move effectively through the local habitat. Thus, changes in noise will affect both vocalizations and sensory drives (Ryan and Brenowitz 1985, Endler 1992). Other constraints, however, may preclude changes in vocalizations. For example, Badyaev et al. (2008) suggested that urban background noise should favor higher-frequency songs, but bill morphology, which is influenced by available food resources, may limit changes in song characteristics. In Arizona, they found that urban House Finches feed on larger, harder foods than their counterparts in the less disturbed Sonoran desert (e.g., sunflower seeds vs. cacti and grass seeds, respectively); they suggested that directional selection has favored larger bills in the urban population, resulting in a tradeoff between bill size and song characteristics important in courtship, particularly trills.

Noise can mask communication.—Masking occurs when sounds hide or interfere with the detection of a biologically relevant sound, such as vocal communication or sounds made by predators. Anthropogenic noise that masks vocal communication among birds can have serious consequences because birds use vocal communication to attract mates and defend territories (Slabbekoorn and Smith 2002, Wood and Yezerinac 2006, Barber et al. 2010); furthermore, noise can mask begging and alarm calls (Warren et al. 2006). Contact calls contribute to maintaining group cohesion, and if noise masks these calls, it can potentially result in lost individuals or breakdown of group cohesion. Exacerbating this problem, the "dawn chorus" temporally overlaps with one of the heaviest commuter-traffic rush hours. Therefore, noise may determine both habitat quality and reproductive success.

For effective communication, sounds transmitted by the sender must be detected by the receiver in forms with unaltered meaning. On the basis of data from 49 avian species tested both physiologically and behaviorally, Dooling and

Popper (2007) reported that birds hear, on average, best at frequencies between 1 and 5 kHz and hear well at the most sensitive frequencies of 2–4 kHz (Dooling 1982). In comparison, humans hear better over a broader frequency (20 Hz to 20 kHz, with most sensitivity 0.5–4.0 KHz; Dooling and Popper 2007); in other words, in general, birds must hear sounds at higher amplitudes than humans. Owls represent an exception and can hear much softer sounds than passerines and many nonpasserines (Dooling and Popper 2007), and some birds can hear in the ultrasonic range (Boncoraglio and Saino 2007). Dooling and Popper (2007) reported a general trend in which passerines and smaller birds also hear better at high frequencies whereas larger birds hear better at low frequencies. Long-distance communication ranges from 0.5 to ~6.0 kHz for typical birds; therefore, studies of masking communication should focus on this range (Dooling and Popper 2007). It may also be useful to provide a signal-to-noise ratio because detection and discrimination depend on both the signal and the background noise (Brumm and Todt 2002; Brumm 2004, 2006).

In Australia, Haff and Magrath (2010) investigated responses of nestling White-browed Scrubwrens (*Sericornis frontalis*) to various sounds; even though they responded (by ceasing begging calls) more strongly to natural predators than to white noise, they responded to broadband (both smooth and erratic) sounds more than to tonal sounds. Earlier, Maurer et al. (2003) had reported that nestling White-browed Scrubwrens begged to parental alarm calls, but they obtained their results under laboratory food-deprivation conditions. Magrath et al. (2007) also reported that adults emit a "food call" when they arrive with food, presumably to reduce the risk of erroneous begging. In Canada, Leonard and Horn (2008) found that nestling Tree Swallows (*Tachycineta bicolor*) responded to experimentally added white noise by emitting begging calls at higher minimum frequency and narrower frequency range, but added noise did not affect nestling growth. However, they used nest boxes, whereas Tree Swallows in natural conditions use cavities. Nestling–parent communication is likely muffled by wood, which differs between boxes and natural cavities. Little work has been done on responses of nestlings to various anthropogenic noise sources (but see Swaddle et al. 2012); however, the studies cited above suggest that noise pollution may affect communication between parents and nestlings.

Very little work has been conducted on birds' responses to what I would call "vocal communication interference levels." This has been extensively studied in humans and is referred to as "speech interference level" (Kryter 1994). It differs from the complete masking phenomenon that covers up or hides sounds; with speech interference, the sound (speech, song, call, etc.) can be heard (it may even be very loud), but the sounds are unintelligible. For example, one can hear people talking very loudly in a room next door yet not understand one word of the conversation. Habib et al. (2007) proposed "song distortion" as an alternative hypothesis to complete masking of vocalization to explain why 15% fewer Ovenbirds experienced successful pairing near noisy compressors compared with quieter control sites. The effects of, or responses to, these garbled sounds may or may not be similar to the effects of complete masking (sounds that cannot even be heard). Pohl et al. (2009) tested this with Great Tits under laboratory conditions and found that noise interfered with signal detection; interestingly, detections were worse during simulations of the dawn chorus compared with both urban and woodland noises.

Birds can change their vocalizations to compensate for the masking effect through (1) changes in song or call frequency, (2) changes in amplitude, (3) changes in song component redundancies, and (4) temporal shifts to avoid morning rush hour or other noise. Birds might also respond to masking by changing their position within the vegetation layer to maximize vocal transmission, but this has not, to my knowledge, been investigated. However, Patricelli et al. (2007, 2008) found that male Red-winged Blackbirds (*Agelaius phoeniceus*) orient themselves to maximize the intent or message of their vocalizations.

Changes in song frequency.—Patricelli and Blickley (2006) suggested two ways in which birds adjust frequency in response to low-frequency noise: (1) by increasing the lowest frequency with no change in the highest frequency, or (2) by shifting the entire vocalization to higher frequency. Slabbekoorn and Peet (2003), Slabbekoorn and den Boer-Visser (2006), and Mockford and Marshall (2009) discovered that Great Tits sing at a higher minimum frequency in noisy locations than in quieter locations. Great Tits apparently have plasticity in their vocal repertoires that enables them to breed successfully in locations with varying noise levels. Halfwerk and Slabbekoorn (2009)

also demonstrated that Great Tits responded to experimentally added low-frequency noise with songs consisting of higher minimum frequency, and they responded to experimentally added high-frequency noise with songs consisting of lower maximum frequency. At least some birds respond to noise with vocal repertoires consisting of songs that differ in frequency (Arcese et al. 2002) and by singing the songs least masked by background noise or by changing the frequency of particular songs in their repertoire (Wood and Yezerinac 2006, Halfwerk and Slabbekoorn 2009). Individuals may learn, during their own sensitive periods, particular songs least masked by noises around them (Wood and Yezerinac 2006).

Many species have shown the same pattern in different parts of the world. Wood and Yezerinac (2006) reported that Song Sparrows in urban areas in and near Portland, Oregon, sing higher-frequency low notes compared with their counterparts living in rural areas. Slabbekoorn et al. (2007) found that Dark-eyed Juncos in urban California sing at higher minimum frequency than populations living in forests. In Vienna, Austria, Nemeth and Brumm (2009) found higher song frequencies and shorter, albeit not statistically significant, intervals between singing bouts among urban Eurasian Blackbirds. Ripmeester et al. (2010) reported that city-dwelling Eurasian Blackbirds in the Netherlands sang at a higher peak frequency than their counterparts in forests. In Australia, Gray Shrike-thrushes increased the frequency of their songs in response to traffic noise (Parris and Schneider 2009). Individual Black-capped Chickadees (*Poecile atricapillus*) also shift the frequency of their song, but this has been reported in social contexts rather than in the context of background noise (Ratcliffe and Weisman 1985, Hill and Lein 1987). Nemeth and Brumm (2009) suggested, as an alternative to masking, that motivational states of higher arousal from higher urban bird densities may also explain the faster-paced, higher-frequency songs. Nemeth and Brumm (2010) further suggested that among urban Great Tits and Eurasian Blackbirds, vocal amplitude had a much larger effect on transmission distance than vocal pitch, and that song frequency shifts might be a side effect of singing at higher amplitudes.

Changes in amplitude.—Amplitude shifts, also referred to as the "Lombard effect" and first described as a human response (Brumm and Todt 2002, Warren et al. 2006; name derived from Lombard 1911), may allow birds to be heard in noisy areas. For example, Common Nightingales increase the volume of their singing with traffic noise (Brumm 2004) and white noise (Brumm and Todt 2002). This response has also been reported in Blue-throated Hummingbirds (*Lampornis clemenciae*), Zebra Finches and Budgerigars (*Melopsittacus undulatus*; reviewed in Warren et al. 2006), and Domestic Fowl (Brumm et al. 2009). Some birds may already produce songs or portions of songs at maximum levels; for example, although Brumm and Todt (2002) found that Common Nightingales sing at higher amplitudes in noisy environments, some elements or portions of their song did not increase in response to increased noise because, presumably, those elements were already at the highest possible amplitude.

Changes in song components and redundancies.—Brumm and Slater (2006) found that in naturally noisy areas, male Common Chaffinches sing some song components for longer bouts than their counterparts in quieter areas. However, they delivered fast trills in shorter bouts, which perhaps suggests a tradeoff between attracting females (attracted to trills) and reducing neuromuscular fatigue. Beyond this study, to my knowledge, very little work has been conducted in this area.

Temporal changes in singing.—We do not know much about species-specific reactions to noise that involve temporal shifts in singing. However, Brumm (2006) found that Common Nightingales can adjust the timing of their peak singing to avoid acoustic interference (in this case, playbacks of other species' songs), and Ficken et al. (1974) reported that Least Flycatchers (*Empidonax minimus*) and Red-eyed Vireos shifted their timing to avoid heterospecific overlap. Fuller et al. (2007) reported shifts from diurnal to nocturnal singing among European Robins (*Erithacus rubecula*). Similar temporal shifts have also been reported in frogs (Zelick and Narins 1982, 1983; Schwartz and Wells 1983; Narins 1995).

Interference with the ability to hear predators and other important sounds.—In addition to communication, hearing is critical for detecting predators and other dangers and opportunities in the environment (Quinn et al. 2006, Slabbekoorn and Ripmeester 2008, Barber et al. 2010). If sounds made by predators, such as footsteps, breathing, and rustling leaves, are masked by noise, the immediate situation becomes considerably more risky for potential prey. Also, even in the absence of noise made

by predators (e.g., aerial predators; Leavesley and Magrath 2005), if noise masks warning calls (by conspecifics or heterospecifics), the perception of danger may be underestimated, resulting in inappropriate, perhaps lethal responses. Conversely, from a predator's perspective, many birds and other animals find food resources through listening (Goerlitz et al. 2008). For example, American Robins (*Turdus migratorius*) listen for sounds of worms underground (Montgomerie and Weatherhead 1997), and many raptors depend on noises made by their prey (Knudsen and Konishi 1979, Rice 1982). This seems a relatively unexplored topic.

Sounds are also critical for an animal's ability to determine its orientation and move across a landscape. The contribution of sounds to the environment is referred to as a "soundscape," and the use of perceived sounds for general orientation within a landscape is referred to as "soundscape orientation" (Slabbekoorn and Bouton 2008). For example, animals use sounds to find water sources and protected areas. Soundscapes are particularly important for nocturnal animals and animals that move through caves or dense vegetation.

Challenges, Needs, and Opportunities

Isolating noise from confounding variables.—Determining effects of noise on free-ranging birds and other wildlife is particularly challenging because we rarely have the opportunity to isolate noise as a single testable variable. Numerous studies have suggested that human disturbances negatively affect birds and other wildlife species in a variety of ways. In many of these studies, noise is coupled with human disturbance, including snowmobiles (Creel et al. 2002, Seip et al. 2007), all-terrain vehicles (Barton and Holmes 2007), trails (Taylor and Knight 2003, Trulio and Sokale 2008), boating (Rodgers and Schwikert 2002, Peters and Otis 2006, Rojek et al. 2007), roads and traffic (Reijnen et al. 1995, Brotons and Herrando 2001), aircraft (Carney and Sydeman 1999, Giese and Riddle 1999, Goudie 2006, Rojek et al. 2007), and ski resorts (Ballenger and Ortega 2001).

However, none of these earlier studies separated noise from the effects of other disturbance. For example, studies on the effect of human noise (talking, laughing, etc.) are confounded with disturbance caused by physical presence of people (Burger and Gochfeld 1998) and with foraging opportunities provided by people (Fernández-Juricic 2001). Similarly, studies on the effects of road or highway noise (Brotons and Herrando 2001) are confounded with effects of habitat fragmentation caused by the roads themselves, the physical movement of traffic, perceived risks of traffic and increased predators, and vehicular exhaust. A few studies have demonstrated that birds and other wildlife can also be negatively affected by nonmotorized human recreational activities—for example, hiking with or without dogs on and off leash, horseback riding, cycling, and ski-slope activities—and some species are more disturbed by humans on foot than by motorized vehicles (Mallord et al. 2007, Patthey et al. 2008, Reed and Merenlender 2008, Stankowich 2008). The most definitive conclusion from most of these studies is that some aspect or several aspects of human disturbance negatively affect birds.

Our ability to detect birds with noise during surveys.—Ortega and Francis (2012) determined that sound pressure levels above 45 dB(A) significantly impaired our ability to detect birds; therefore, surveys in noisy areas likely underestimate bird occupancy. This is particularly relevant in studies aimed at comparing sites that differ in noise levels. For example, studies of fragmentation are often coupled with noisy activities, such as roads and other development. The effects of background noise clearly vary among observers' abilities to aurally detect birds, and species vary in their detectability. Pacifici et al. (2008) reported at 100 m, detection probabilities ranged from 0 to 1, and 3–99% of birdsongs were detected during a birdsong simulation experiment. They suggested that surveys focused on particular species might yield the best results. However, when the objective is to compare communities between or among sites, surveyors need to count all birds. In another simulated experiment, Simons et al. (2007) found that observers overcount within 50 m and undercount beyond that distance, and the mean number of birdsongs detected decreased by 41% with 10 dB(A) of added white noise.

Indirect effects that could change landscapes.—The indirect effects of noise, to my knowledge, have not been well studied, but at least one study has suggested potential effects on habitat because some birds that provide ecological services, such as pollination and seed dispersal, are affected either positively (e.g., Black-chinned Hummingbirds) or negatively (e.g., Western Scrub-Jays) by noise (Francis et al. 2009, 2012; Ortega and Francis 2012). Francis et al. (2009) reported on the potential of noise pollution from gas well compressors

to alter the future distribution of piñon–juniper (*Pinus edulis–Juniperus osteosperma*) forests because at least one of the main dispersers (Western Scrub-Jays) of piñons were notably absent from the noisy compressor sites. Currently, we do not know how noise indirectly affects other habitats.

Who regulates noise, where, and how?—The federal Office of Noise Abatement and Control (under the authority of the Environmental Protection Act) closed in 1981 because they concluded that noise issues would be better handled at the local level. Currently, states, counties, and municipalities regulate noise from an anthropocentric perspective with little or no consideration for wildlife species, although some federal land management agencies set their own noise tolerance levels for the benefit of wildlife, but usually for charismatic species sensitive to disturbance. Local regulations are often very lenient, with many loopholes, exclusions, and exemptions that promote special interests (for links to state regulations, see www.epa.gov/epahome/state.htm). For example, in Colorado, under Article 12, Noise abatement, section 25-12-103, Maximum permissible noise levels: "This article is not applicable to the use of property for the purpose of manufacturing, maintaining, or grooming machine-made snow." Other exclusions include athletic, entertainment, cultural, and patriotic events.

Sound pressure levels are also very lenient. For example, in Colorado, the limit set for motorized vehicles measured from 50 feet (15.2 m) from the center line of a road is 86 dB(A) and 90 dB(A) for speeds less than and exceeding, respectively, 35 mph (56.3 kph). Limits for off-road vehicles are almost as lenient, at 82 dB(A) and 86 dB(A) for below and above 35 mph (56.3 kph), respectively. Additionally, the same regulations state that

> In all sound level measurements, consideration shall be given to the effect of the ambient noise level created by the encompassing noise of the environment from all sources at the time and place of such sound level measurement.

This does not take into account the cumulative effects of noise pollution and makes for regulation with little or no teeth, set within a framework of ambiguity.

Without more stringent and enforceable regulations, reducing noise pollution will require citizen consciousness and compliance. With increasing urban sprawl and its associated noise pollution, louder and more frequent noises throughout the world, and bird population declines, the responsibility rests with researchers to provide useful information on the effects of noise pollution on birds and other wildlife and how noise can best be mitigated.

What kind of mitigation is possible?—In order to plan mitigation for noise, we need to understand the major sources of noise. Anthropogenic noise is nothing new, but the sounds of outdoor markets and horses clopping along cobblestone streets have been traded for more contemporary noises that now dominate our soundscape. Noise can conveniently be categorized as (1) long-term and relatively constant, such as noise from industry and business as well as housing (e.g., air conditioning and exhaust fans); (2) regular but intermittent, such as air and road traffic; and (3) temporary noise, such as military activities, special events, and domestic conveniences (e.g., lawn mowers, chainsaws, weed trimmers, leaf blowers, snow blowers, cell phones, car horns and alarms). Many temporary noises, however, collectively produce a constant urban hum.

Most noises can be muffled better; others are unnecessary (e.g., car horns to confirm activated alarms). Noise from industry can also be muffled, but unless regulations require it, industries may not volunteer to pay the high cost of current mitigation technology, such as noise reduction barriers. Bayne et al. (2008) estimated that retrofitting a compressor station with sound reduction equipment would cost $35,000–50,000. They also compared the estimated $175–250 million cost to reduce noise by 4 dB(A) throughout the energy sector in boreal Alberta with the $100 billion influx from the energy sector over the next 5 to 10 years (Habib et al. 2007, Bayne et al. 2008); they suggested that it would be a cost-effective best management practice.

Mitigation measures that have been suggested to reduce traffic noise include (1) using road surfaces that absorb more sound (Slabbekoorn and Ripmeester 2008, Blickley and Patricelli 2010); (2) reducing speed, especially during the breeding season (Makarewicz and Kokowski 2007, Parris and Schneider 2009, Slabbekoorn and Ripmeester 2008); (3) shuttle buses, especially in parks (Barber et al. 2010); and (4) seasonal road closures in important breeding areas to the extent feasible (Slabbekoorn and Ripmeester 2008). Parris and Schneider (2009) and Blickley and Patricelli (2010) pointed out that sound barriers for roads would reduce noise pollution but hinder wildlife movements. This is a management area in need of

further investigation. For many species, sound barriers make movement across roads difficult or impossible, but they may also prevent animal–vehicle collisions. Sound barriers do not necessarily have to extend to the ground and, coupled with wildlife overpasses, could be a potential solution, at least in some areas. Research on solutions as well as potential implementation might be funded by a noise tax (Sandberg 1991).

Mitigation measures will come with a financial burden; therefore, it is unlikely that industry will adopt them voluntarily or that citizens will willingly accept mitigation costs passed on by industry. As Blickley and Patricelli (2010) suggested, reduction of noise pollution will take policy action in terms of adjusted noise-level standards and mitigation measures to meet new standards. Before policy makers can make these important and perhaps controversial decisions, they will need compelling scientific evidence that noise negatively affects some species of birds and other wildlife, especially species of concern.

Although variation exists among species, the difference in masking threshold is ~6 dB(A) less in humans than in birds; in other words, humans can detect sounds with 6 dB(A) greater background noise compared with the typical bird (Dooling and Popper 2007). This has important implications for potential mitigation. Sound pressure levels decrease by ~6 dB(A) for every doubling of distance from the sound source. This implies that at least some birds can no longer detect a sound at half the distance from the noise source as a human can hear it. Therefore, humans are poor judges of what masks sounds for birds. In other words, compared with humans, birds may be less disturbed by noise closer to the source (e.g., highway noise, compressor noise, etc.), but the masking effects are greater.

Future research needs.—The EPA identified a need for research in three major areas involving the effects of noise on wildlife: (1) effects of long-term exposure to moderate noise levels, (2) whether wild animals experience the same adverse reactions to noise as laboratory animals, and (3) the ecological consequences of masking and altered behavioral patterns (EPA 1980). Thirty years have passed since the agency made these suggestions; however, relatively few research efforts since have addressed these three areas of need.

More recently, Warren et al. (2006) also suggested three, albeit different, areas in need of research: (1) the relationship between spatial distribution of noise and variation in communication, (2) potential relationship between timing of noise levels and the dawn chorus, and (3) the acoustics of canyons. They pointed out that, in addition to contributing to knowledge that benefits conservation and management planning strategies, these research topics would have the additional benefit of contributing to our overall knowledge of avian communication.

We are still on the forefront of our understanding of how at least some birds can adjust their vocalizations in response to noise pollution. But to my knowledge, in addition to the above research suggestions, we do not yet know the answers to many other critical questions (outlined below) and how all the information (known and unknown) interconnects.

(1) We know that some species change frequency or loudness of their songs in response to noise, but our knowledge comes from relatively few species. In order to generalize about common responses of birds to noise, we must increase our understanding of species-specific responses, covering at least the major taxonomic groups of birds. It may also be useful to know whether species within the major taxonomic groups of birds respond to noise in similar ways.

(2) Most research on effects of noise on bird communication has focused on song. However, other important vocalizations (e.g., alarm calls, contact calls, begging vocalizations, and invitation-to-copulation calls) have not been studied as much.

(3) We know little about how females respond to changes in vocalization or whether noise interferes with their ability to orient themselves in a spatially appropriate manner. Most of our knowledge comes from a few studies of frogs. For example, Bee and Swanson (2007; cited in Barber et al. 2010) reported that female Gray Treefrogs (*Hyla chrysoscelis*) take longer to orient themselves to male signals in the presence of traffic noise playbacks. Parris et al. (2009) pointed out a tradeoff between audibility and mate attraction in frogs that may apply to at least some bird species. They suggested that female Common Eastern Froglets (*Crinia signifera*) prefer lower-frequency songs because they indicate larger males, yet males call at a higher frequency in areas of traffic noise.

(4) In natural habitats, sound does not attenuate in a symmetrical spherical pattern because of permanent (e.g., topography) and temporary (e.g., atmospheric conditions) features. In general, lower frequencies degrade less in dense vegetation than

higher frequencies; however, lower frequencies attenuate more rapidly when emitted close to the ground (Boncoraglio and Saino 2007). Animals can spatially orient themselves to maximize hearing and vocalizing. For example, some birds directionally orient themselves in ways that maximize transmission of communication (Boncoraglio and Saino 2007, Patricelli et al. 2008). Therefore, one might expect that birds can change their position within the vegetation layers in addition to directional orientation to maximize their vocal transmissions.

(5) There may be an interesting relationship between abundance of certain species in noisy areas and their song frequency; birds with higher dominant song frequency may be more abundant near roads and other noisy areas (Rheindt 2003). Further investigation would help us predict effects of noise, particularly with new roads, industry, and energy extraction activities.

(6) Very little work has teased apart two major elements of noise masking: detection (signal not heard) and discrimination (signal heard but unintelligible). Distinction between these elements might be important if birds can still respond to certain components of a garbled song or call.

(7) We do not have an understanding of how noise has affected, or might affect in the future, birds at the population level. A necessary component of this would be to gain a better understanding of the effects of noise on the communication system between nestlings and their parents. Potential population changes will likely have to be modeled using soundscape information in geographic information systems (GIS). This will open up opportunities for interdisciplinary collaboration with GIS experts, planners, architects, acoustical physicists, agencies, and biologists in various disciplines. Many workgroups are already working on soundscape maps; for example, noise contours are regularly mapped for airports (Warren et al. 2006), and the National Park Service is developing a soundscape program. GIS maps with context options (e.g., time of day, seasons, and when particular events such as train trips or sporting events occur) should be invaluable tools for predicting bird population changes due to noise.

(8) We do not, to my knowledge, know how noise might affect competition for resources. For example, Ortega and Francis (2012) found that Violet-green Swallows (*Tachycineta thalassina*) are significantly more common on treatment sites (with noisy compressors) than on control sites (gas wells without compressors). One hypothesis is that the compressor noise eliminates bats that might overlap with swallows during the dawn and dusk hours, leaving more food resources for swallows.

(9) In order to determine the role of noise in predator–prey relationships, we need to better understand how noise affects the success of predators by masking sounds of their prey. Conversely, we need to understand how noise affects the ability of prey to detect predators.

(10) As mentioned above, noise is often difficult to study as a single testable variable. Several studies have used noise from gas well compressors because the noise can be turned off, and these sites can easily be compared with ecologically similar habitat adjacent to or surrounding gas wells without compressors. Conversely, adding noise is relatively easy but has both advantages and disadvantages of creating a situation that birds did not choose. It is easier to study human-created noise—at least in some situations, such as the energy sector—than to study the effects of noise in the natural world. However, it is not impossible to isolate naturally occurring noises. One opportunity to isolate naturally occurring noise as a single testable variable involves noise from flowing water. This may be logistically challenging but not impossible. Regulated streams can be "turned off" long enough to conduct bird surveys or experiments. These periods can be compared with times when streams flow and are noisy. Dam operators might be willing to cooperate as long as the requested times do not significantly interfere with water delivery. It could even be as simple as coordinating research activities with already scheduled dam operations.

(11) Many birds provide ecological services, such as seed dispersal, pollination, and pest control. At this point in time, we have a poor understanding of how noise affects these birds and how these effects may, in turn, affect the future distribution of certain habitats.

(12) Many birds incorporate songs of other species into their vocal repertoires. For example, David Attenborough hosted a revealing video of a Superb Lyrebird (*Menura novaehollandiae*) imitating sounds of camera shutters, car alarms, and chainsaws (www.youtube.com/watch?v=OFDdtRD5ED8). Similar accounts exist on the Internet of other birds, especially Northern Mockingbirds (*Mimus polyglottos*) and Eurasian Blackbirds (Stover 2009), imitating various cell phone rings and tones, ambulances, and other common urban noises. Presumably, incorporation of these anthropogenic

noises increases their overall repertoires, yet we do not know how females respond to these novel vocalizations.

The Future for Birds in a Noisier World

Noise is nothing new to many avian species, especially colonial species that collectively make deafening noises themselves. Some species have presumably lived with natural sound, such as streams, waterfalls, and wind, for a very long time. Anthropogenic noise pollution will continue to challenge many other species, and whether or not they can coexist with noise will depend on (1) the degree of sound spectrum overlap between anthropogenic noise and important acoustic cues in their world; (2) the degree to which other sensory forms can compensate for reduced hearing; (3) how other organisms (e.g., predators, competitors, parasites, seed dispersers, pollinators, and other organisms that provide ecological services) in the community respond to noise pollution; and (4) the extent to which males and females can coordinate their responses.

Sounds have always been an integral part of the environment, but changes by humans, resulting in noise pollution, have disturbed the integrity of natural ecosystems. Barber et al. (2010:8) suggested that "Taken collectively, the preponderance of evidence argues for immediate action to manage noise in protected natural areas." Management of noise will be necessary to maintain or restore the integrity of natural ecosystems. This will require numerous actions: (1) sound scientific research to better understand the complicated and sometimes seemingly underlying effects of noise pollution; (2) raising the collective consciousness of society about the harmful effects, including information on how citizens can reduce their contribution to noise pollution; and (3) working with policy makers to tighten regulations and enforcement of noise sources.

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Noise pollution alters ecological services: enhanced pollination and disrupted seed dispersal

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Noise pollution is a novel, widespread environmental force that has recently been shown to alter the behaviour and distribution of birds and other vertebrates, yet whether noise has cumulative, community-level consequences by changing critical ecological services is unknown. Herein, we examined the effects of noise pollution on pollination and seed dispersal and seedling establishment within a study system that isolated the effects of noise from confounding stimuli common to human-altered landscapes. Using observations, vegetation surveys and pollen transfer and seed removal experiments, we found that effects of noise pollution can reverberate through communities by disrupting or enhancing these ecological services. Specifically, noise pollution indirectly increased artificial flower pollination by hummingbirds, but altered the community of animals that prey upon and disperse *Pinus edulis* seeds, potentially explaining reduced *P. edulis* seedling recruitment in noisy areas. Despite evidence that some ecological services, such as pollination, may benefit indirectly owing to noise, declines in seedling recruitment for key-dominant species such as *P. edulis* may have dramatic long-term effects on ecosystem structure and diversity. Because the extent of noise pollution is growing, this study emphasizes that investigators should evaluate the ecological consequences of noise alongside other human-induced environmental changes that are reshaping human-altered landscapes worldwide.

Keywords: anthropogenic noise; birds; ecological service; human disturbance; pollination; seed dispersal

1. INTRODUCTION

Human activities have altered over 75 per cent of the Earth's land surface [1,2]. Concomitant with these surface changes is a pervasive increase in anthropogenic noise, or noise pollution, caused by expanding dendritic transportation networks, urban centres and industrial activities [3]. The geographical extent of noise exposure varies by region and scale, but estimates suggest that one-fifth of the United States' land area is impacted by traffic noise directly [4] and over 80 per cent of some rural landscapes are exposed to increased noise levels owing to energy extraction activities [5]. Despite the potentially substantial scale of noise exposure across the globe, surprisingly little is known about how these ecologically novel acoustic conditions affect natural populations and communities.

We are beginning to understand the impacts of increased noise exposure on the behaviours of individuals and the distributions of species [6–10], and several recent reviews outline potential and some known effects of noise [3,11–13]. Despite this recent attention given to the effects of noise, we still have limited knowledge of how these impacts scale to community and ecosystem-level processes. A few studies have shown that predators avoid noisy areas [7,14–16], presumably because noise impairs predators' abilities to locate prey. These studies provide us with insights on how noise may directly affect predator–prey interactions, but do not provide information on whether noise may have cumulative, indirect consequences for other interactions and organisms that are not impacted by noise directly.

Our goal was to investigate whether noise pollution can reverberate through ecological communities by affecting species that provide functionally unique ecological services. We focused our efforts on ecological services provided primarily by birds because they are considered to be especially sensitive to noise pollution owing to their reliance on acoustic communication [11]. However, because not all species respond uniformly to noise exposure [6,7,10,17], we can evaluate how different responses by functionally unique species impact other organisms indirectly and trigger further changes to community structure. We studied ecological services provided by *Archilochus alexandri* (black-chinned hummingbird) and *Aphelocoma californica* (western scrub-jay), which serve as mobile links for pollination and *Pinus edulis* (piñon) seed dispersal services, respectively [18–20]. Because *A. alexandri* preferentially nests in noisy environments and *A. californica* avoids noisy areas [5,7], we proposed that their noise-dependent distributions could result in a higher rate of pollination

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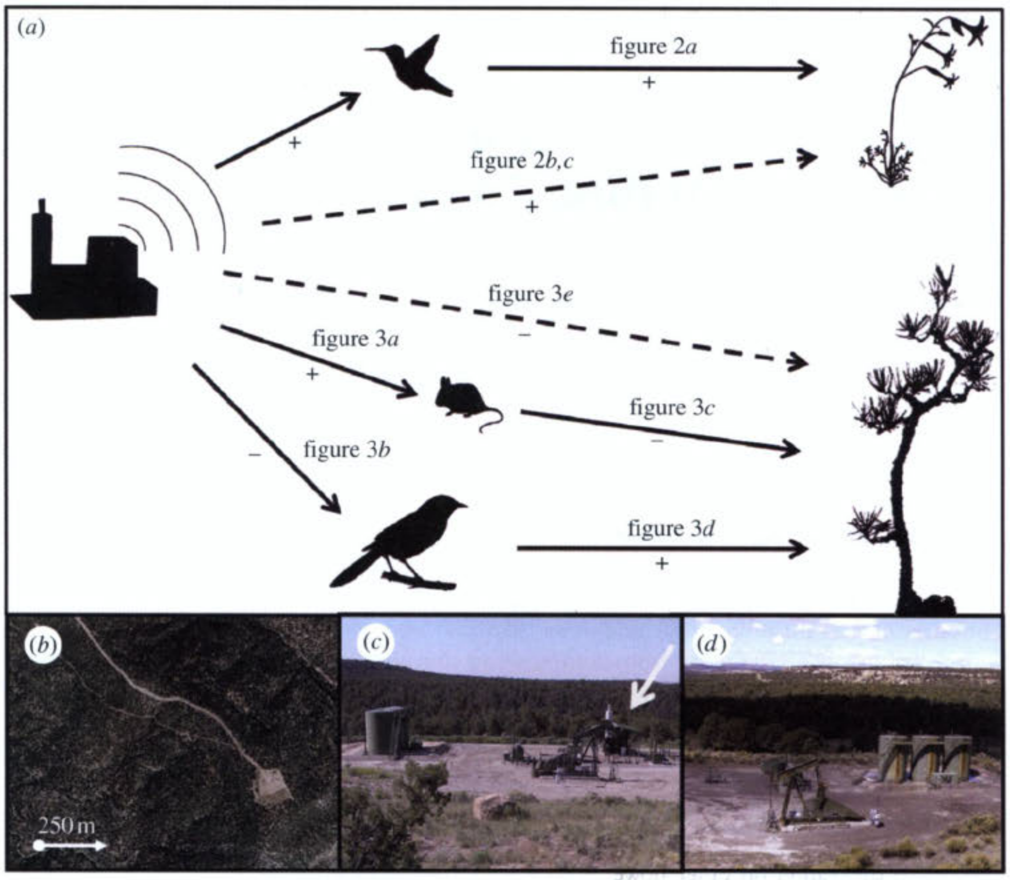

Figure 1. (*a*) Pathway by which noise alters pollination and seed dispersal services. Solid and dashed arrows denote direct and indirect interactions, respectively. Signs refer to effect direction, and support for each effect is indicated by figure number. See main text for results and citations supporting the dependence of *I. aggregata* on *A. alexandri* (arrow labelled figure 2*a*) and for the functional quality of *Peromyscus* mice and *A. californica* as *P. edulis* seed dispersers (arrows labelled figure 3*c*,*d*). (*b*) Active gas wells located at the end of access roads served as (*c*) noisy treatment sites owing to the presence of noise-generating gas well compressors (white arrow) or (*d*) quiet control sites.

for hummingbird-pollinated plants and disrupt *P. edulis* seed dispersal services in noisy areas and potentially affect seedling recruitment (figure 1*a*).

To test these predictions, we used a unique study system that isolates the influence of noise exposure from many confounding factors common to noisy areas, such as vegetation heterogeneity, edge effects and the presence of humans and moving vehicles (see below). We used observations, vegetation surveys and pollen transfer and seed-removal experiments on pairs of treatment and control sites to determine how ecological interactions differ in noisy and quiet areas and whether noise indirectly affects plants that depend on functionally unique avian mobile links.

2. MATERIAL AND METHODS

Our study took place in the Rattlesnake Canyon Habitat Management Area (RCHMA), located in northwestern New Mexico. Study area and site details can be found elsewhere [5–7]. Briefly, RCHMA is dominated by woodland consisting of *P. edulis* and *Juniperus osteosperma* (juniper) and has a high density of natural gas wells (figure 1*b*). Many wells are coupled with compressors that run continuously and generate noise at high amplitudes (greater than 95 dB(A) at a distance of 1 m), and, like most anthropogenic noise, compressor noise has substantial energy at low frequencies and diminishes towards higher frequencies (electronic supplementary material, figure S1) [5–7]. Additionally, human activity at wells and major vegetation features in the woodlands surrounding wells do not differ between wells with (noisy treatment sites) and without noise-generating compressors (quiet control sites, figure 1*c*,*d*)[7], providing an opportunity to evaluate the indirect effect of noise on supporting ecological services in the absence of many confounding stimuli common to most human-altered landscapes.

(a) *Pollination experiment*

To determine whether hummingbird-pollinated flowers indirectly benefit from noise, we used a field experiment controlling for the density and the spatial arrangement of hummingbird nectar resources with patches of artificial flowers that mimicked a self-incompatible, hummingbird-pollinated plant common to our study area: *Ipomopsis aggregata* (electronic supplementary material, figures S2 and S3*a*). In May 2010, we established seven pairs of treatment and control sites within RCHMA for the pollination experiments. Sites were paired geographically to minimize potential differences in vegetation features within each pair; however, to ensure that background noise levels were significantly different between paired sites, sites were greater than or equal to 500 m apart and resulted in relatively quiet conditions at control sites. The resulting distance between treatment-control pairs was 767 m (± 57 s.e.m., minimum = 520 m, maximum = 954 m).

Artificial flower patches were established 125 m from either the wellhead or compressor on control and treatment sites,

respectively (electronic supplementary material, figure S2*a*). The direction of the first patch relative to the wellhead or compressor was determined randomly and the second patch was established 40 m from the first and also at 125 m from the wellhead or compressor. Prior to the experiment, at each patch, we measured background noise amplitude as A-weighted decibels (dB(A)) for 1 min to confirm that noise levels were significantly higher at treatment patches relative to control patches. In all cases, measurements on paired treatment and control sites were completed on the same day and at approximately the same time. We measured amplitude as the equivalent continuous noise level (L_{eq}, *fast* response time) with Casella convertible sound dosimeter/sound pressure metres (model CEL 320 and CEL 1002 converter). We used 95 mm acoustical windscreens, and we did not take measurements when wind conditions were categorized three or above on the Beaufort Wind Scale (approx. 13–18 km h^{-1}), or when sounds other than compressor noise (i.e. bird vocalizations and aircraft noise) could bias measurements.

Artificial flowers are frequently used in pollination studies [21,22] and those used in our experiment were constructed from 0.6 ml microcentrifuge tubes. This microcentrifuge tube size had been used previously in pollination experiments with *A. alexandri* [23]. To mimic the appearance of *I. aggregata*, we wrapped each microcentrifuge tube with red electrical tape (electronic supplementary material, figure S3). Additionally, we attached three small pieces of yellow yarn to provide a substrate for marking flowers with fluorescent dye and subsequent transfer and deposition on other flowers by pollinators. Each artificial plant consisted of three flowers attached to a 53 cm long metal rod with green electrical tape (electronic supplementary material, figure S3*b*). Patches of plants were arranged in a 3 m^2 area with four plants marking each corner and one at the centre (electronic supplementary material, figure S2*a*).

Plant patches were established simultaneously or one immediately after another (less than or equal to 30 min) on paired sites. Because *I. aggregata* nectar is 20–25% sucrose [24,25], we filled each flower with a reward of 0.4 ml 25 per cent sucrose solution with pipettes and calibrated plastic droppers, returning each day at approximately the same time to refill the flower with the sucrose reward so that pollinators learned to use the flowers as a foraging resource. Only rarely did we encounter a single artificial flower completely depleted of the reward between visits to replenish the reward, but never all three flowers on the same plant.

We conducted observations to determine pollinator visitation rates at 11 (79%) of 14 pairs of treatment and control patches. Because the establishment of our patches took several days, prior to our observations, four pairs of patches were refilled for 4 days, two patches were refilled for 3 days and five patches were refilled for 2 days and all observed patches had been established for greater than 38 h prior to observation. We then conducted observations at patches on pairs of control and treatment sites simultaneously or one immediately after the other. We watched flowers at focal patches for 15 min and tallied the number of visits to each plant from a distance of 5 m, using binoculars when necessary to identify arthropods visiting the flowers. All non-hummingbird pollinators were separated into their orders (Hymenoptera, Diptera and Lepidoptera) and we used Poisson generalized linear-mixed models (GLMM) within the lme4 package in R [26] to examine whether patch visitations by *A. alexandri* or other pollinators differed between treatment and control sites. Individual sites and geographically paired sites were treated as random effects.

Following focal observations, on 28 May 2010, we returned to all patches between 07.00 and 12.00 to refill all artificial flowers with the sucrose reward and uniquely marked one plant per patch with either yellow or red fluorescent powder (Day-Glo Color Corporation, Cleveland, Ohio, USA) such that plants within the same site but at different patches received a unique coloured powder. Use of fluorescent powder as a proxy for pollen transfer is a technique widely used in pollination studies because the transfer of powder is strongly correlated with the transfer of pollen [27,28]. Each patch was permitted 24 h of exposure for pollinator visits before we collected each plant for subsequent examination for powder transfer in the laboratory.

In the laboratory, we used an ultraviolet lamp under dark conditions to record the presence or absence of powder on each inflorescence, noting whether the powder was from the marked plant within the same patch or the patch located at 40 m. We then used Poisson GLMMs to examine within-patch and between-patch pollen transfer with number of individual flowers per patch with transferred pollen as response variables. We treated each site and geographically paired treatment and control site as random effects in all models.

(b) Pinus edulis *seed-removal experiment*

We conducted *P. edulis* seed-removal experiments throughout RCHMA to determine whether and how seed-removal rates and the community of seed predators and dispersers respond to noise exposure. *Pinus edulis* trees within a region typically synchronize production of large-cone crops every 5–7 years [20]. As cones gradually dry and open in September, seeds not harvested by corvids from cones in the canopy fall to the ground where rodents, corvids and other bird species consume and harvest seeds for several months [20]. Monitoring rates of autumn seed removal from the ground can be problematic as seeds continue to fall from trees; therefore, we conducted our experiments in June–July when no other *P. edulis* seeds were available, similar to other studies that have examined *P. edulis* seed removal and dispersal during summer months [29].

We used six pairs of treatment and control sites that were geographically coupled. Sites met those same criteria described for the pollination experiment. The mean distance between treatment-control pairs was 821 m (±51 s.e.m., minimum = 642 m, maximum = 1029 m). At each site, we established seed stations at 10 locations within 150 m of each well or compressor (electronic supplementary material, figure S2*b*). Locations were selected randomly provided that the distance between each station was greater than or equal to 40 m, and each station was located on the ground under a reproductively mature *P. edulis* tree.

Seed-removal experiments lasted for 72 h with visits to each station every 24 h to quantify the daily rate of seed removal. At the beginning of each 24 h period, we simulated natural seed fall by scattering 20 *P. edulis* seeds on the ground in a 0.125 m^2 area. We then returned 24 h later to document the number of removed seeds, determine whether there was evidence for *in situ* seed predation by carefully searching the immediate area (approx. 2 m^2) for newly opened *P. edulis* seeds (usually conspicuous as a clumped collection of seed-coat fragments from several seeds) and to again scatter 20 seeds at the station. Evidence of seed predation

at a station was defined as whether recently opened (and empty) seed coats were detected during any of the three visits used to quantify seed-removal rate. All seeds were collected locally within RCHMA and were handled with latex gloves so that human scent was not transferred to the seeds. During one of the four visits to each station, we measured background noise amplitude following the methods described above for the pollination experiment.

To document the identity of animals removing seeds, we paired each station with a motion-triggered digital camera (Wildview Xtreme II). Cameras were mounted on a trunk or a branch of an adjacent tree within 1–3 m from the seed station for a clear view, yet positioned in a relatively inconspicuous location to avoid drawing additional attention to the station. Cameras remained on each station for the entire 72 h period and documented both diurnal and nocturnal seed removal. A positive detection of a species removing seeds was recorded only when an individual was documented removing or consuming seeds.

The number of seeds removed per 24 h period was used to calculate a daily mean proportion of seeds removed, which we arcsine square-root transformed to meet assumptions of normality and homogeneity of variance. We used linear-mixed models (LMMs) to examine whether the proportion of seeds removed differed between treatment and control seed stations or owing to the presence or absence of individual species. We used binomial GLMMs to determine how the presence of individual species explained *in situ* seed predation, evidenced by the presence of newly opened *P. edulis* seed coats. For the models in which we examined the influence of individual species on seed removal or predation, we started with models containing all documented species as predictor variables and proceeded to remove each non-significant variable one at a time based on the highest p-value until only significant effects remained. We used Poisson and binomial GLMMs to examine whether species richness of the seed removing community and detections of individual species differed at treatment and control seed stations, respectively. For all models, we treated each site and geographically paired treatment and control sites as random effects. Some models evaluating detections of individual species on treatment and control sites would not converge; therefore, for these cases, we used χ^2-tests to determine whether there was a difference between the total number of detections on control and treatment sites.

(c) *Seedling recruitment surveys*

In 2007, we completed 129 random vegetation surveys on 25 m diameter vegetation plots (approx. 490 m^2) located on nine treatment and eight control sites, some of which were not the same sites used in the seed-removal experiments, which included only six pairs of sites (12 total). Ten treatment sites were surveyed in 2007, but we excluded vegetation plots from one site from this analysis because the compressor was installed in 2006, thus confounding the acoustic conditions during which many seedlings may have been established (see below). Compressors on all other treatment sites had been in place for at least 6 years, but over 10 years for several sites.

Because our fieldwork in previous years had documented an avoidance of noise by *A. californica* [7], in 2007, we counted all *P. edulis* seedlings per vegetation plot. We restricted counts of seedlings to those less than or equal to 20 cm to make sure that they had been dispersed and established relatively recently and under the same acoustic conditions that were present in 2007. We assumed seedlings less than or equal to 20 cm had been dispersed and established within the previous 6 years because 1 year-old *P. edulis* seedlings were measured to have an average height of 5.3 cm [30] and because the closely related *Pinus cembroides* reaches a height of 1 m at around 5 years old [31]. Thus, our assumptions should be considered conservative. We analysed seedling recruitment with the number of seedlings per plot as the response variable using Poisson GLMMs. Predictor variables included plot location on either a treatment or control site, but also plot-level features that may influence seedling establishment and recruitment, such as the number of shrubs, *P. edulis* and *J. osteosperma* trees, the amount of canopy cover, leaf litter depth and the proportion of ground cover classified as living material, dead matter or bare ground. Site identity was treated as a random effect. We followed the same model selection procedure described above for seed removal and seed predation. Data for seedling recruitment, plus data from the seed removal and pollination experiments have been deposited at Dryad (www.datadryad.org; doi:10.5061/dryad.6d2ps7s7).

3. RESULTS

(a) *Pollination*

Noise amplitude values were significantly higher (approx. 12 dB(A)) at treatment patches relative to control patches (LMM: $\chi^2_1 = 25.550, p < 0.001$, electronic supplementary material, figure S2*c*) and similar to those experienced approximately 500 m from motorways [32,33]. Focal observations at a subset of patches revealed that several taxa visited artificial flowers supplied with a nectar reward (electronic supplementary material, table S1), yet only *A. alexandri* visits differed between treatment and control sites. *Archilochus alexandri* visits were five times more common at treatment patches than control patches (Poisson GLMM: $\chi^2_1 = 6.859, p = 0.009$, figure 2*a*).

Consistent with more *A. alexandri* visits to plants in noisy areas, within-patch pollen transfer occurred for 5 per cent of control site flowers, but 18 per cent of treatment site flowers (Poisson GLMM: $\chi^2_1 = 15.518, p < 0.001$, figure 2*b*) and between-patch pollen transfer occurred for 1 per cent of control site flowers and 5 per cent of treatment site flowers (Poisson GLMM: $\chi^2_1 = 6.120$, $p = 0.013$, figure 2*c*). Analyses using the presence or absence of transferred pollen at the patch level revealed the same pattern (within-patch binomial GLMM: $\chi^2_1 = 8.800$, $p = 0.003$; between-patch binomial GLMM: $\chi^2_1 = 5.608, p = 0.018$).

(b) Pinus edulis *seed removal*

Noise amplitude values were consistently higher (approx. 14 dB(A)) at treatment seed stations relative to control seed stations (LMM: $\chi^2_1 = 19.084$, $p < 0.001$, electronic supplementary material, figure S2*d*), yet neither seed-removal rate (LMM: $\chi^2_1 = 2.209$, $p = 0.137$), nor documented species richness per seed station differed between sites with and without noise (Poisson GLMM: $\chi^2_1 = 0.461, p = 0.497$).

The majority of animals detected with motion-triggered cameras removing seeds from stations were easily identified to species; however, for two groups, *Peromyscus* mice and *Sylvilagus* rabbits, we were not always able to identify individuals to species; therefore, they were assigned to their

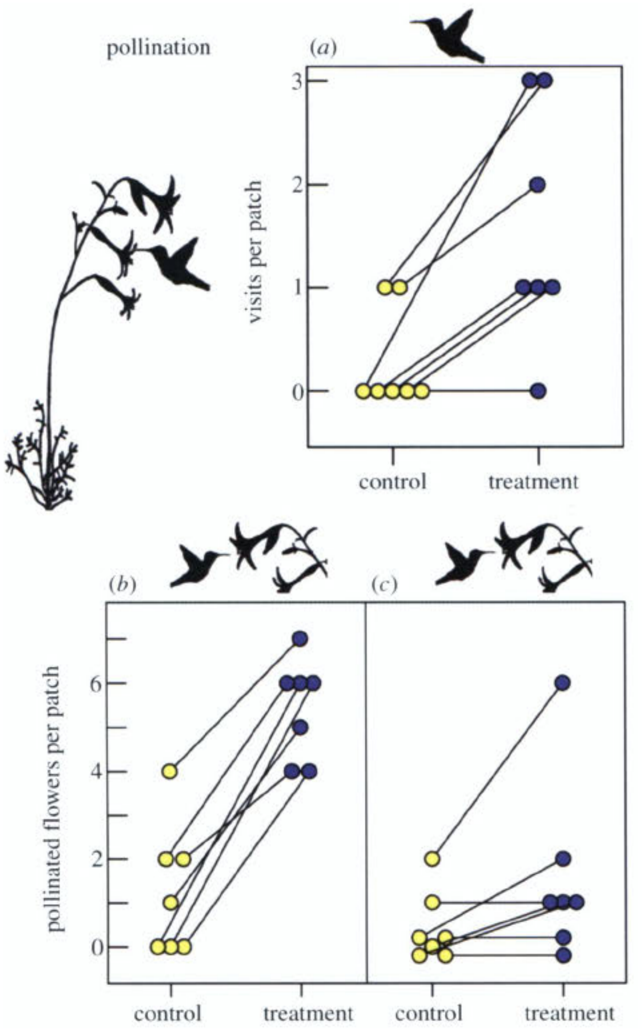

Figure 2. Evidence from pollination experiment. (*a*) *Archilochus alexandri* visited artificial flowers on noisy treatment patches more than quiet control site patches. The values displayed reflect the sum of visits per site (14 sites total with two patches per site, five plants per patch and three flower per plant). (*b,c*) Pollination of individual flowers was higher on treatment sites relative to control sites both (*b*) within and (*c*) between patches. Values displayed reflect the sum of pollinated flowers in both patches per site. (*a-c*) Lines link geographically paired sites.

respective genera. In total, we document 11 taxa removing seeds, nine of which were considered seed predators (electronic supplementary material, table S2). Cameras failed to detect the identity of animals that removed seeds at approximately one station per site, primarily owing to battery failure. However, there was no difference in the number of camera failures between treatment and control sites that would suggest our detections were biased towards one site type over the other (binomial GLMM: $\chi^2_1 = 0.240$, $p = 0.624$); therefore, any relative differences in detections between treatment and control sites should reflect actual differences between noisy and quiet areas.

Of the nine seed predators documented removing seeds, only one, *Pipilo maculatus*, was detected more frequently on control sites relative to treatment sites (binomial GLMM: $\chi^2_1 = 4.133$, $p = 0.042$); a pattern consistent with previous findings that *P. maculatus* avoids noise in its nest placement [7]. We also documented seed removal by *Peromyscus* mice and *A. californica*, considered to be primarily seed predators and important seed dispersers, respectively [20]. Mice were detected at 63 per cent of treatment seed stations and only 45 per cent of control stations (binomial GLMM: $\chi^2_1 = 4.023$, $p = 0.045$; figure 3*a*). By contrast, *A. californica* was detected removing seeds exclusively at control stations ($\chi^2_1 = 5.486$, $p = 0.019$; figure 3*b*). *Peromyscus* mice and *A. californica* were also the only taxa with strong effects on seed removal and, along with *Tamias minimus*, were taxa with strong influences on patterns of seed predation at the seed station (i.e. presence of opened seed coats). Seed removal rates were approximately 30 per cent higher at stations where *Peromyscus* mice or *A. californica* were documented removing seeds compared with stations where they were not detected (LMM: $\chi^2_2 = 35.775$, $p < 0.001$; figure 3*c,d*). Seed predation was positively affected by the presence of *Peromyscus* mice ($\beta_{\text{mouse}} = 0.841 \pm 0.412$ s.e.) and *T. minimus* ($\beta_{\text{chipmunk}} = 1.199 \pm 0.544$ s.e.), both typically considered seed predators [20], but negatively affected by the presence of *A. calilfornia* ($\beta_{\text{scrub-jay}} = -2.031 \pm 1.005$ s.e.; binomial GLMM: $\chi^2_3 = 13.748$, $p = 0.003$). Indeed, most stations where *Peromyscus* mice (74%) and *T. minimus* (81%) were detected also had evidence of seed predation, but only 33 per cent of stations where *A. california* was detected were there signs of seed predation.

(c) Pinus edulis *seedling recruitment*

Consistent with the difference in animals removing seeds in noisy and quiet areas, *P. edulis* seedlings were four times more abundant on control sites relative to treatment sites ($\beta_{\text{Treatment}} = -1.543 \pm 0.240$ s.e.; figure 3*e*), but number of *J. osteosperma* trees ($\beta_{\text{Juniper}} = 0.036 \pm 0.016$ s.e.) and the proportion of dead organic ground cover ($\beta_{\text{Dead}} = 0.023 \pm 0.008$ s.e.) had small, positive effects on seedling abundance (Poisson GLMM: $\chi^2_3 = 38.583$, $p < 0.001$). However, neither of these variables, nor number of *P. edulis* trees, differed between treatment and control sites (juniper LMM: $\chi^2_1 = 0.726$, $p = 0.394$; dead ground cover LMM: $\chi^2_1 = 0$, $p = 1.0$; *P. edulis* LMM: $\chi^2_1 = 2.560$, $p = 0.110$), suggesting that other habitat features can be excluded as alternative explanations for *P. edulis* seedling recruitment on treatment and control sites.

4. DISCUSSION

Elevated noise levels affected pollination rates by hummingbirds and *P. edulis* seed dispersal and seedling recruitment, but the direction of each effect was different. Noise exposure had an indirect positive effect on pollination by hummingbirds, but an indirect negative effect on *P. edulis* seedling establishment by altering the composition of animals preying upon or dispersing seeds. These results extend our knowledge of the consequences of noise exposure, which has primarily focused on vocal responses to noise [8,34,35], somewhat on species distributions and reproductive success [7,10,32,36] and very little on species interactions [7,14–16]. In an example of the latter, traffic noise negatively affects bat (*Myotis myotis*) foraging efficiency by impairing its ability to locate prey by listening to sounds generated from prey movement [14]. Here, our data demonstrate that the frequency of species interactions can change without a direct effect of noise on the interaction itself, suggesting that noise exposure may trigger changes to numerous ecological interactions and reverberate through communities.

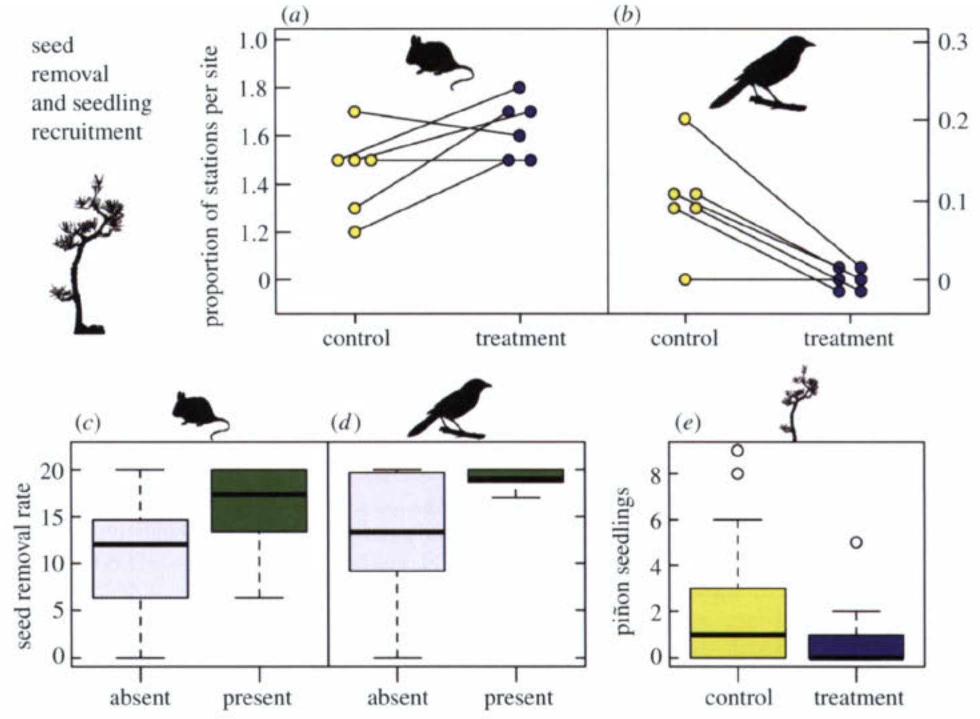

Figure 3. (*a*) *Peromyscus* mice were detected more frequently at treatment seed stations relative to control stations. (*b*) *A. californica* removed seeds exclusively on control sites. Values displayed in (*a*) and (*b*) reflect the proportion of seed stations per site where mice or jays were detected. (*c,d*) Seed removal rates (per 24 h) were higher when (*c*) *Peromyscus* mice or (*d*) *A. californica* were detected at a seed station. (*e*) *Pinus edulis* seedling recruitment was significantly higher on control sites relative to treatment sites. Box plots indicate the median value (solid black line), 25th and 75th percentiles (box), and whiskers denote 1.5 the interquartile range. Outliers are denoted by open circles.

Increases in pollination rates were in line with our prediction based on the positive responses to noise by *A. alexandri*, both in terms of nest-site selection [7] and abundances determined from surveys [17]. Our experimental design and use of artificial flowers were advantageous because we could control for variation in density and the spatial arrangement of nectar resources that can influence pollination patterns [37]. However, this approach precluded us from determining whether increases in pollination in noisy areas results in greater seed and fruit production. This is probable for *I. aggregata* because it can be pollen limited throughout its range [38–40] and fruit set is strongly correlated with pollinator (e.g. hummingbird) abundance [18]. Therefore, noise-dependent increases in *A. alexandri* abundances [7,17] coupled with increases in visits to artificial flowers in this study is suggestive that *I. aggregata* plants exposed to elevated noise levels may have greater reproductive output relative to individuals in quiet areas.

Seed removal, seed predation and seedling recruitment data were consistent with one another and our expectations, suggesting that noise has the potential to indirectly affect woodland structure. It is plausible that the suite of species removing seeds may differ in June and July when we conducted our study from that found in the autumn when seeds are typically available. Yet, all species documented removing seeds are year-round residents and their relative abundances are unlikely to fluctuate between treatment and control sites throughout the year. Instead, it is more likely that we underestimated the magnitude of the difference in seed dispersal quality between noisy and quiet areas for two main reasons. First, because *A. californica* typically provision young with protein-rich animal prey [41], individuals at our study area may have been foraging primarily on animal prey rather than *P. edulis* seeds during our experiments. Second, our use of seed stations on the ground did not account for seed removal from cones in the canopy by other important seed dispersers, such as *Gymnorhinus cyanocephalus* (piñon jay); a species that occurs in RCHMA, but also avoids noisy areas [7,42]. The degree to which these factors contribute to reduced seedling recruitment in noisy areas is unknown, but provides an interesting avenue of research for future study.

Although, *A. californica* and *Peromyscus* mice had the greatest influence on seed-removal rates, we were unable to track the fate of individual seeds. Nevertheless, these species influenced patterns of seed predation in a manner consistent with knowledge of how these species differ as mobile links for *P. edulis* seed dispersal and seedling establishment. Evidence of seed predation was less common at seed stations visited by *A. californica*, potentially reflecting its role as an important disperser of *P. edulis* seeds. For example, one *A. californica* individual may cache up to 6000 *P. edulis* seeds in locations favourable for germination during a single autumn [43]. Many seeds are relocated and consumed, but many go unrecovered and germinate [20]. By contrast, although *Peromyscus* mice might function as conditional dispersers under some circumstances [44,45], here their presence at a seed station was a strong predictor of seed predation, reflecting their primary role as seed predators [20]. Previous research using experimental enclosures to study caching behaviour in the field supports our findings [29,44]. *Peromyscus* mice consume a large proportion (approx. 40%) of encountered seeds and typically cache

many encountered seeds that are not immediately consumed [44]. Yet, cached seeds are often recovered and eaten (greater than 80%) along with seeds cached by other individuals or species [29]. Thus, the reduced density of seedlings in noisy areas could be explained not only by fewer seeds entering the seed bank as a result of reduced densities of important avian seed dispersers that cache many thousands of seeds, but because seeds present within the seed bank experience elevated rates of predation via cache pilfering associated with noise-dependent increases in *Peromyscus* mice.

Despite the concordance between our findings and the literature regarding the roles of *A. californica* and *Peromyscus* mice on *P. edulis* seed dispersal and predation, seedling mortality caused by key seedling predators, such as *Odocoileus hemionus* (mule deer) and *Cervus canadensis* (elk), could potentially explain the higher density of seedlings in quiet relative to noisy areas. However, ungulates such as *C. canadensis* appear to avoid areas exposed to noise from high traffic volume [46], suggesting that seedling mortality owing to browsing ungulates should be greater in areas with less noise and leading to a pattern opposite from that which we observed. Still needed are confirmatory studies that track the fate of cached seeds and document patterns of seedling predation within noisy and quiet areas.

Despite the downstream consequences of species-specific response to noise exposure, the mechanistic reasons for species-specific responses are still not clear. *Aphelocoma californica* may avoid noisy areas because noise can mask their vocal communication. Larger birds with lower frequency vocalizations are more sensitive to noise than smaller species with higher frequency vocalizations because their vocalizations overlap low-frequencies where noise has more acoustic energy [17]. *Aphelocoma californica* is also the main nest predator in the study area [7,16] and it is possible that noise masks acoustic cues used to locate prey at nests (e.g. nestling and parent calls). It is also possible that these forms of acoustic interference may lead to elevated stress levels that could influence patterns of habitat use [13], but research on this potential link is currently lacking.

In contrast to the direct effect noise may have on *A. californica* communication and foraging, positive responses to noise by *A. alexandri* and *Peromyscus* mice probably reflect indirect responses to noise. Noisy areas may represent refugia from predators and key competitors that typically avoid noisy areas, including jays. For example, *A. alexandri* may preferentially settle in noisy areas in response to cues indicative of lower nest predation pressure from *A. californica*. Similarly, *Peromyscus* mice populations may increase in noisy areas not only because of reduced competition with *A. californica* and other jays for key-foraging resources, but also in response to reduced predation by nocturnal acoustic predators that may avoid noise [14], such as owls.

That noise may alter patterns of seedling recruitment adds important insights to our earlier work where we found neither *P. edulis* tree density, nor 12 other habitat features differed between treatment and control sites [7]. This, however, may be slowly changing. Reduced *P. edulis* seedling recruitment in noisy areas may eventually translate into fewer mature trees, yet because *P. edulis* is slow growing and has long generation times [47], these initial changes in stand structure could have gone undetected for decades. Such long-term changes may have important implications for the woodland community as a whole by prolonging the negative consequences of noise exposure. That is, noise may not only result in large declines in diversity during exposure by causing site abandonment or reduced densities by many species [7,10], but diversity may suffer long after noise sources are gone because fewer *P. edulis* trees will provide less critical habitat for the many hundreds of species that depend on them for survival [48].

These separate experiments highlight that noise pollution is a strong environmental force that may alter key ecological processes and services. Over a decade ago, Forman [4] estimated that approximately one-fifth of the land area in the United States is affected by traffic noise, yet the actual geographical extent of noise exposure is undoubtedly greater when other sources are considered. Additionally, this spatial footprint of noise, the anthropogenic soundscape, will only increase because sources of noise pollution are growing at a faster rate than the human population [3]. These data suggest that anthropogenic soundscapes have or will encompass nearly all terrestrial habitat types, potentially impacting innumerable species interactions both directly and indirectly. It is critical that we identify which other functionally unique species abandon or preferentially settle in other noisy areas around the world. Early detection of altered species distributions and the resulting disrupted or enhanced ecological services will be key to understanding the trajectory of the many populations and communities that outwardly appear to persist despite our industrial rumble.

This study was completed in compliance with the University of Colorado Animal Care and Use Committee.

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Noise pollution alters ecological services: enhanced pollination and disrupted seed dispersal

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Noise pollution alters ecological services: enhanced pollination and disrupted seed dispersal

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Noise pollution is a novel, widespread environmental force that has recently been shown to alter the behaviour and distribution of birds and other vertebrates, yet whether noise has cumulative, community-level consequences by changing critical ecological services is unknown. Herein, we examined the effects of noise pollution on pollination and seed dispersal and seedling establishment within a study system that isolated the effects of noise from confounding stimuli common to human-altered landscapes. Using observations, vegetation surveys and pollen transfer and seed removal experiments, we found that effects of noise pollution can reverberate through communities by disrupting or enhancing these ecological services. Specifically, noise pollution indirectly increased artificial flower pollination by hummingbirds, but altered the community of animals that prey upon and disperse *Pinus edulis* seeds, potentially explaining reduced *P. edulis* seedling recruitment in noisy areas. Despite evidence that some ecological services, such as pollination, may benefit indirectly owing to noise, declines in seedling recruitment for key-dominant species such as *P. edulis* may have dramatic long-term effects on ecosystem structure and diversity. Because the extent of noise pollution is growing, this study emphasizes that investigators should evaluate the ecological consequences of noise alongside other human-induced environmental changes that are reshaping human-altered landscapes worldwide.

Keywords: anthropogenic noise; birds; ecological service; human disturbance; pollination; seed dispersal

1. INTRODUCTION

Human activities have altered over 75 per cent of the Earth's land surface [1,2]. Concomitant with these surface changes is a pervasive increase in anthropogenic noise, or noise pollution, caused by expanding dendritic transportation networks, urban centres and industrial activities [3]. The geographical extent of noise exposure varies by region and scale, but estimates suggest that one-fifth of the United States' land area is impacted by traffic noise directly [4] and over 80 per cent of some rural landscapes are exposed to increased noise levels owing to energy extraction activities [5]. Despite the potentially substantial scale of noise exposure across the globe, surprisingly little is known about how these ecologically novel acoustic conditions affect natural populations and communities.

We are beginning to understand the impacts of increased noise exposure on the behaviours of individuals and the distributions of species [6–10], and several recent reviews outline potential and some known effects of noise [3,11–13]. Despite this recent attention given to the effects of noise, we still have limited knowledge of how these impacts scale to community and ecosystem-level processes. A few studies have shown that predators avoid noisy areas [7,14–16], presumably because noise impairs predators' abilities to locate prey. These studies provide us with insights on how noise may directly affect predator–prey interactions, but do not provide information on whether noise may have cumulative, indirect consequences for other interactions and organisms that are not impacted by noise directly.

Our goal was to investigate whether noise pollution can reverberate through ecological communities by affecting species that provide functionally unique ecological services. We focused our efforts on ecological services provided primarily by birds because they are considered to be especially sensitive to noise pollution owing to their reliance on acoustic communication [11]. However, because not all species respond uniformly to noise exposure [6,7,10,17], we can evaluate how different responses by functionally unique species impact other organisms indirectly and trigger further changes to community structure. We studied ecological services provided by *Archilochus alexandri* (black-chinned hummingbird) and *Aphelocoma californica* (western scrub-jay), which serve as mobile links for pollination and *Pinus edulis* (piñon) seed dispersal services, respectively [18–20]. Because *A. alexandri* preferentially nests in noisy environments and *A. californica* avoids noisy areas [5,7], we proposed that their noise-dependent distributions could result in a higher rate of pollination

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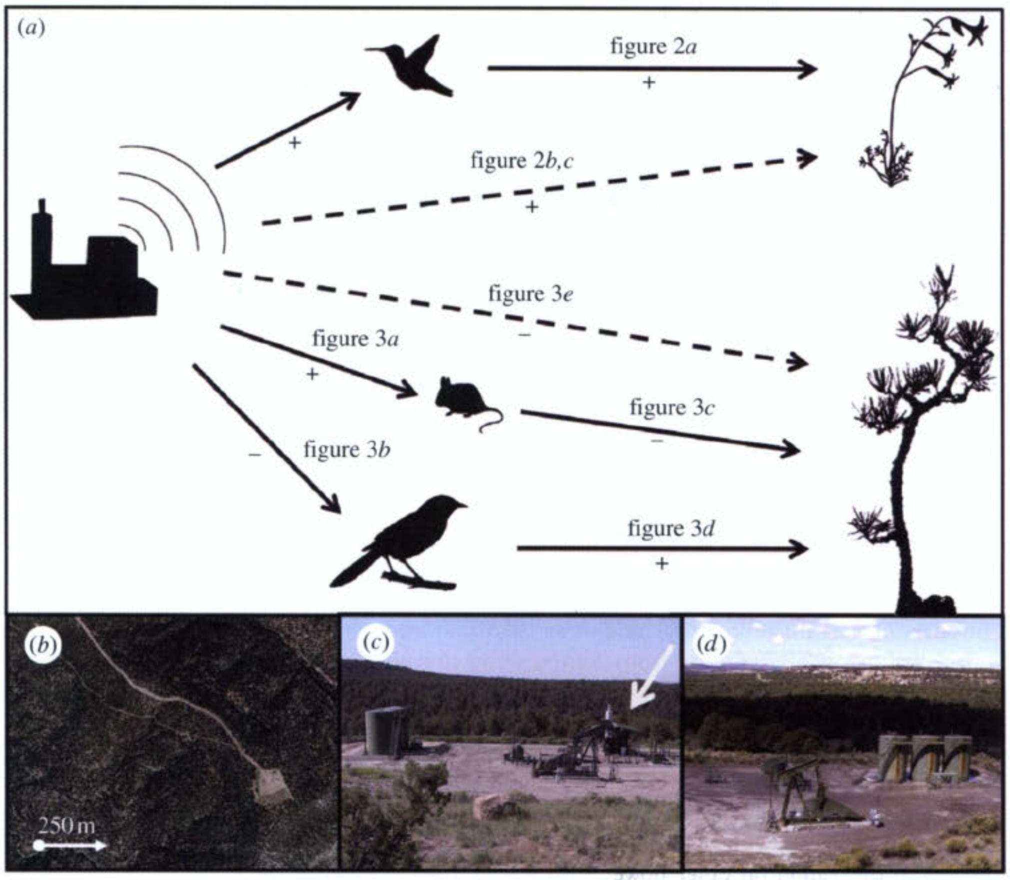

Figure 1. (*a*) Pathway by which noise alters pollination and seed dispersal services. Solid and dashed arrows denote direct and indirect interactions, respectively. Signs refer to effect direction, and support for each effect is indicated by figure number. See main text for results and citations supporting the dependence of *I. aggregata* on *A. alexandri* (arrow labelled figure 2*a*) and for the functional quality of *Peromyscus* mice and *A. californica* as *P. edulis* seed dispersers (arrows labelled figure 3*c*,*d*). (*b*) Active gas wells located at the end of access roads served as (*c*) noisy treatment sites owing to the presence of noise-generating gas well compressors (white arrow) or (*d*) quiet control sites.

for hummingbird-pollinated plants and disrupt *P. edulis* seed dispersal services in noisy areas and potentially affect seedling recruitment (figure 1*a*).

To test these predictions, we used a unique study system that isolates the influence of noise exposure from many confounding factors common to noisy areas, such as vegetation heterogeneity, edge effects and the presence of humans and moving vehicles (see below). We used observations, vegetation surveys and pollen transfer and seed-removal experiments on pairs of treatment and control sites to determine how ecological interactions differ in noisy and quiet areas and whether noise indirectly affects plants that depend on functionally unique avian mobile links.

2. MATERIAL AND METHODS

Our study took place in the Rattlesnake Canyon Habitat Management Area (RCHMA), located in northwestern New Mexico. Study area and site details can be found elsewhere [5–7]. Briefly, RCHMA is dominated by woodland consisting of *P. edulis* and *Juniperus osteosperma* (juniper) and has a high density of natural gas wells (figure 1*b*). Many wells are coupled with compressors that run continuously and generate noise at high amplitudes (greater than 95 dB(A) at a distance of 1 m), and, like most anthropogenic noise, compressor noise has substantial energy at low frequencies and diminishes towards higher frequencies (electronic supplementary material, figure S1) [5–7]. Additionally, human activity at wells and major vegetation features in the woodlands surrounding wells do not differ between wells with (noisy treatment sites) and without noise-generating compressors (quiet control sites, figure 1*c*,*d*)[7], providing an opportunity to evaluate the indirect effect of noise on supporting ecological services in the absence of many confounding stimuli common to most human-altered landscapes.

(a) *Pollination experiment*

To determine whether hummingbird-pollinated flowers indirectly benefit from noise, we used a field experiment controlling for the density and the spatial arrangement of hummingbird nectar resources with patches of artificial flowers that mimicked a self-incompatible, hummingbird-pollinated plant common to our study area: *Ipomopsis aggregata* (electronic supplementary material, figures S2 and S3*a*). In May 2010, we established seven pairs of treatment and control sites within RCHMA for the pollination experiments. Sites were paired geographically to minimize potential differences in vegetation features within each pair; however, to ensure that background noise levels were significantly different between paired sites, sites were greater than or equal to 500 m apart and resulted in relatively quiet conditions at control sites. The resulting distance between treatment-control pairs was 767 m (± 57 s.e.m., minimum = 520 m, maximum = 954 m).

Artificial flower patches were established 125 m from either the wellhead or compressor on control and treatment sites,

respectively (electronic supplementary material, figure S2*a*). The direction of the first patch relative to the wellhead or compressor was determined randomly and the second patch was established 40 m from the first and also at 125 m from the wellhead or compressor. Prior to the experiment, at each patch, we measured background noise amplitude as A-weighted decibels (dB(A)) for 1 min to confirm that noise levels were significantly higher at treatment patches relative to control patches. In all cases, measurements on paired treatment and control sites were completed on the same day and at approximately the same time. We measured amplitude as the equivalent continuous noise level (L_{eq}, *fast* response time) with Casella convertible sound dosimeter/sound pressure metres (model CEL 320 and CEL 1002 converter). We used 95 mm acoustical windscreens, and we did not take measurements when wind conditions were categorized three or above on the Beaufort Wind Scale (approx. 13–18 km h^{-1}), or when sounds other than compressor noise (i.e. bird vocalizations and aircraft noise) could bias measurements.

Artificial flowers are frequently used in pollination studies [21,22] and those used in our experiment were constructed from 0.6 ml microcentrifuge tubes. This microcentrifuge tube size had been used previously in pollination experiments with *A. alexandri* [23]. To mimic the appearance of *I. aggregata*, we wrapped each microcentrifuge tube with red electrical tape (electronic supplementary material, figure S3). Additionally, we attached three small pieces of yellow yarn to provide a substrate for marking flowers with fluorescent dye and subsequent transfer and deposition on other flowers by pollinators. Each artificial plant consisted of three flowers attached to a 53 cm long metal rod with green electrical tape (electronic supplementary material, figure S3*b*). Patches of plants were arranged in a 3 m^2 area with four plants marking each corner and one at the centre (electronic supplementary material, figure S2*a*).

Plant patches were established simultaneously or one immediately after another (less than or equal to 30 min) on paired sites. Because *I. aggregata* nectar is 20–25% sucrose [24,25], we filled each flower with a reward of 0.4 ml 25 per cent sucrose solution with pipettes and calibrated plastic droppers, returning each day at approximately the same time to refill the flower with the sucrose reward so that pollinators learned to use the flowers as a foraging resource. Only rarely did we encounter a single artificial flower completely depleted of the reward between visits to replenish the reward, but never all three flowers on the same plant.

We conducted observations to determine pollinator visitation rates at 11 (79%) of 14 pairs of treatment and control patches. Because the establishment of our patches took several days, prior to our observations, four pairs of patches were refilled for 4 days, two patches were refilled for 3 days and five patches were refilled for 2 days and all observed patches had been established for greater than 38 h prior to observation. We then conducted observations at patches on pairs of control and treatment sites simultaneously or one immediately after the other. We watched flowers at focal patches for 15 min and tallied the number of visits to each plant from a distance of 5 m, using binoculars when necessary to identify arthropods visiting the flowers. All non-hummingbird pollinators were separated into their orders (Hymenoptera, Diptera and Lepidoptera) and we used Poisson generalized linear-mixed models (GLMM) within the lme4 package in R [26] to examine whether patch visitations by *A. alexandri* or other pollinators differed between treatment and control sites. Individual sites and geographically paired sites were treated as random effects.

Following focal observations, on 28 May 2010, we returned to all patches between 07.00 and 12.00 to refill all artificial flowers with the sucrose reward and uniquely marked one plant per patch with either yellow or red fluorescent powder (Day-Glo Color Corporation, Cleveland, Ohio, USA) such that plants within the same site but at different patches received a unique coloured powder. Use of fluorescent powder as a proxy for pollen transfer is a technique widely used in pollination studies because the transfer of powder is strongly correlated with the transfer of pollen [27,28]. Each patch was permitted 24 h of exposure for pollinator visits before we collected each plant for subsequent examination for powder transfer in the laboratory.

In the laboratory, we used an ultraviolet lamp under dark conditions to record the presence or absence of powder on each inflorescence, noting whether the powder was from the marked plant within the same patch or the patch located at 40 m. We then used Poisson GLMMs to examine within-patch and between-patch pollen transfer with number of individual flowers per patch with transferred pollen as response variables. We treated each site and geographically paired treatment and control site as random effects in all models.

(b) Pinus edulis *seed-removal experiment*

We conducted *P. edulis* seed-removal experiments throughout RCHMA to determine whether and how seed-removal rates and the community of seed predators and dispersers respond to noise exposure. *Pinus edulis* trees within a region typically synchronize production of large-cone crops every 5–7 years [20]. As cones gradually dry and open in September, seeds not harvested by corvids from cones in the canopy fall to the ground where rodents, corvids and other bird species consume and harvest seeds for several months [20]. Monitoring rates of autumn seed removal from the ground can be problematic as seeds continue to fall from trees; therefore, we conducted our experiments in June–July when no other *P. edulis* seeds were available, similar to other studies that have examined *P. edulis* seed removal and dispersal during summer months [29].

We used six pairs of treatment and control sites that were geographically coupled. Sites met those same criteria described for the pollination experiment. The mean distance between treatment-control pairs was 821 m ($\pm$51 s.e.m., minimum = 642 m, maximum = 1029 m). At each site, we established seed stations at 10 locations within 150 m of each well or compressor (electronic supplementary material, figure S2*b*). Locations were selected randomly provided that the distance between each station was greater than or equal to 40 m, and each station was located on the ground under a reproductively mature *P. edulis* tree.

Seed-removal experiments lasted for 72 h with visits to each station every 24 h to quantify the daily rate of seed removal. At the beginning of each 24 h period, we simulated natural seed fall by scattering 20 *P. edulis* seeds on the ground in a 0.125 m^2 area. We then returned 24 h later to document the number of removed seeds, determine whether there was evidence for *in situ* seed predation by carefully searching the immediate area (approx. 2 m^2) for newly opened *P. edulis* seeds (usually conspicuous as a clumped collection of seed-coat fragments from several seeds) and to again scatter 20 seeds at the station. Evidence of seed predation

at a station was defined as whether recently opened (and empty) seed coats were detected during any of the three visits used to quantify seed-removal rate. All seeds were collected locally within RCHMA and were handled with latex gloves so that human scent was not transferred to the seeds. During one of the four visits to each station, we measured background noise amplitude following the methods described above for the pollination experiment.

To document the identity of animals removing seeds, we paired each station with a motion-triggered digital camera (Wildview Xtreme II). Cameras were mounted on a trunk or a branch of an adjacent tree within 1–3 m from the seed station for a clear view, yet positioned in a relatively inconspicuous location to avoid drawing additional attention to the station. Cameras remained on each station for the entire 72 h period and documented both diurnal and nocturnal seed removal. A positive detection of a species removing seeds was recorded only when an individual was documented removing or consuming seeds.

The number of seeds removed per 24 h period was used to calculate a daily mean proportion of seeds removed, which we arcsine square-root transformed to meet assumptions of normality and homogeneity of variance. We used linear-mixed models (LMMs) to examine whether the proportion of seeds removed differed between treatment and control seed stations or owing to the presence or absence of individual species. We used binomial GLMMs to determine how the presence of individual species explained *in situ* seed predation, evidenced by the presence of newly opened *P. edulis* seed coats. For the models in which we examined the influence of individual species on seed removal or predation, we started with models containing all documented species as predictor variables and proceeded to remove each non-significant variable one at a time based on the highest p-value until only significant effects remained. We used Poisson and binomial GLMMs to examine whether species richness of the seed removing community and detections of individual species differed at treatment and control seed stations, respectively. For all models, we treated each site and geographically paired treatment and control sites as random effects. Some models evaluating detections of individual species on treatment and control sites would not converge; therefore, for these cases, we used χ^2-tests to determine whether there was a difference between the total number of detections on control and treatment sites.

(c) *Seedling recruitment surveys*

In 2007, we completed 129 random vegetation surveys on 25 m diameter vegetation plots (approx. 490 m^2) located on nine treatment and eight control sites, some of which were not the same sites used in the seed-removal experiments, which included only six pairs of sites (12 total). Ten treatment sites were surveyed in 2007, but we excluded vegetation plots from one site from this analysis because the compressor was installed in 2006, thus confounding the acoustic conditions during which many seedlings may have been established (see below). Compressors on all other treatment sites had been in place for at least 6 years, but over 10 years for several sites.

Because our fieldwork in previous years had documented an avoidance of noise by *A. californica* [7], in 2007, we counted all *P. edulis* seedlings per vegetation plot. We restricted counts of seedlings to those less than or equal to 20 cm to make sure that they had been dispersed and established relatively recently and under the same acoustic conditions that were present in 2007. We assumed seedlings less than or equal to 20 cm had been dispersed and established within the previous 6 years because 1 year-old *P. edulis* seedlings were measured to have an average height of 5.3 cm [30] and because the closely related *Pinus cembroides* reaches a height of 1 m at around 5 years old [31]. Thus, our assumptions should be considered conservative. We analysed seedling recruitment with the number of seedlings per plot as the response variable using Poisson GLMMs. Predictor variables included plot location on either a treatment or control site, but also plot-level features that may influence seedling establishment and recruitment, such as the number of shrubs, *P. edulis* and *J. osteosperma* trees, the amount of canopy cover, leaf litter depth and the proportion of ground cover classified as living material, dead matter or bare ground. Site identity was treated as a random effect. We followed the same model selection procedure described above for seed removal and seed predation. Data for seedling recruitment, plus data from the seed removal and pollination experiments have been deposited at Dryad (www.datadryad.org; doi:10.5061/dryad.6d2ps7s7).

3. RESULTS

(a) *Pollination*

Noise amplitude values were significantly higher (approx. 12 dB(A)) at treatment patches relative to control patches (LMM: $\chi^2_1 = 25.550, p < 0.001$, electronic supplementary material, figure S2*c*) and similar to those experienced approximately 500 m from motorways [32,33]. Focal observations at a subset of patches revealed that several taxa visited artificial flowers supplied with a nectar reward (electronic supplementary material, table S1), yet only *A. alexandri* visits differed between treatment and control sites. *Archilochus alexandri* visits were five times more common at treatment patches than control patches (Poisson GLMM: $\chi^2_1 = 6.859, p = 0.009$, figure 2*a*).

Consistent with more *A. alexandri* visits to plants in noisy areas, within-patch pollen transfer occurred for 5 per cent of control site flowers, but 18 per cent of treatment site flowers (Poisson GLMM: $\chi^2_1 = 15.518, p < 0.001$, figure 2*b*) and between-patch pollen transfer occurred for 1 per cent of control site flowers and 5 per cent of treatment site flowers (Poisson GLMM: $\chi^2_1 = 6.120$, $p = 0.013$, figure 2*c*). Analyses using the presence or absence of transferred pollen at the patch level revealed the same pattern (within-patch binomial GLMM: $\chi^2_1 = 8.800$, $p = 0.003$; between-patch binomial GLMM: $\chi^2_1 = 5.608, p = 0.018$).

(b) **Pinus edulis** *seed removal*

Noise amplitude values were consistently higher (approx. 14 dB(A)) at treatment seed stations relative to control seed stations (LMM: $\chi^2_1 = 19.084$, $p < 0.001$, electronic supplementary material, figure S2*d*), yet neither seed-removal rate (LMM: $\chi^2_1 = 2.209$, $p = 0.137$), nor documented species richness per seed station differed between sites with and without noise (Poisson GLMM: $\chi^2_1 = 0.461, p = 0.497$).

The majority of animals detected with motion-triggered cameras removing seeds from stations were easily identified to species; however, for two groups, *Peromyscus* mice and *Sylvilagus* rabbits, we were not always able to identify individuals to species; therefore, they were assigned to their

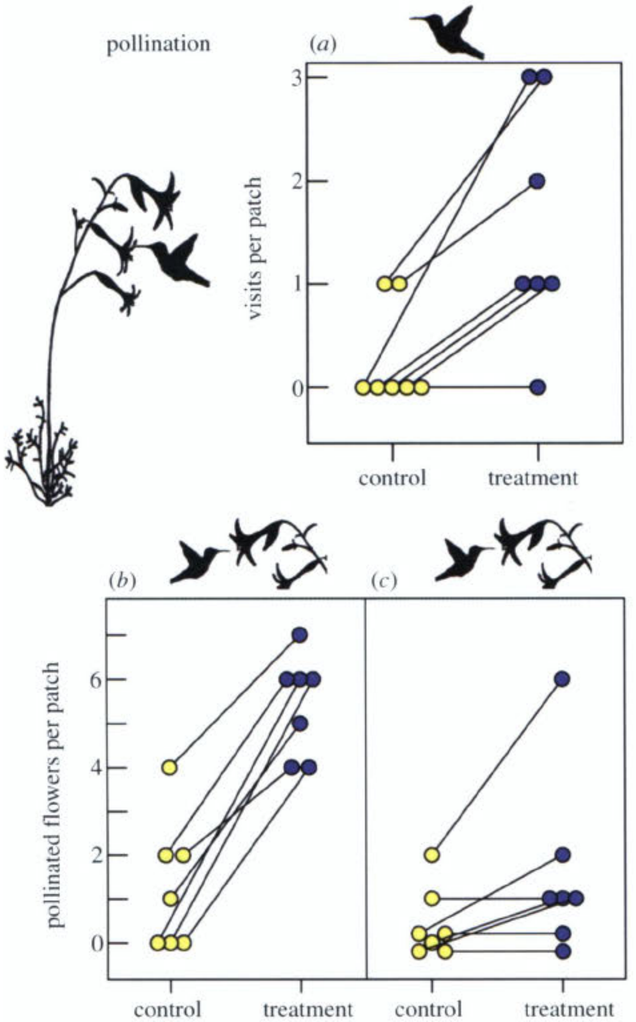

Figure 2. Evidence from pollination experiment. (*a*) *Archilochus alexandri* visited artificial flowers on noisy treatment patches more than quiet control site patches. The values displayed reflect the sum of visits per site (14 sites total with two patches per site, five plants per patch and three flower per plant). (*b,c*) Pollination of individual flowers was higher on treatment sites relative to control sites both (*b*) within and (*c*) between patches. Values displayed reflect the sum of pollinated flowers in both patches per site. (*a-c*) Lines link geographically paired sites.

respective genera. In total, we document 11 taxa removing seeds, nine of which were considered seed predators (electronic supplementary material, table S2). Cameras failed to detect the identity of animals that removed seeds at approximately one station per site, primarily owing to battery failure. However, there was no difference in the number of camera failures between treatment and control sites that would suggest our detections were biased towards one site type over the other (binomial GLMM: $\chi_1^2 = 0.240$, $p = 0.624$); therefore, any relative differences in detections between treatment and control sites should reflect actual differences between noisy and quiet areas.

Of the nine seed predators documented removing seeds, only one, *Pipilo maculatus*, was detected more frequently on control sites relative to treatment sites (binomial GLMM: $\chi_1^2 = 4.133$, $p = 0.042$); a pattern consistent with previous findings that *P. maculatus* avoids noise in its nest placement [7]. We also documented seed removal by *Peromyscus* mice and *A. californica*, considered to be primarily seed predators and important seed dispersers, respectively [20]. Mice were detected at 63 per cent of treatment seed stations and only 45 per cent of control stations (binomial GLMM: $\chi_1^2 = 4.023$, $p = 0.045$; figure 3*a*). By contrast, *A. californica* was detected removing seeds exclusively at control stations ($\chi_1^2 = 5.486$, $p = 0.019$; figure 3*b*). *Peromyscus* mice and *A. californica* were also the only taxa with strong effects on seed removal and, along with *Tamias minimus*, were taxa with strong influences on patterns of seed predation at the seed station (i.e. presence of opened seed coats). Seed removal rates were approximately 30 per cent higher at stations where *Peromyscus* mice or *A. californica* were documented removing seeds compared with stations where they were not detected (LMM: $\chi_2^2 = 35.775$, $p < 0.001$; figure 3*c,d*). Seed predation was positively affected by the presence of *Peromyscus* mice ($\beta_{\text{mouse}} = 0.841 \pm 0.412$ s.e.) and *T. minimus* ($\beta_{\text{chipmunk}} = 1.199 \pm 0.544$ s.e.), both typically considered seed predators [20], but negatively affected by the presence of *A. calilfornia* ($\beta_{\text{scrub-jay}} = -2.031 \pm 1.005$ s.e.; binomial GLMM: $\chi_3^2 = 13.748$, $p = 0.003$). Indeed, most stations where *Peromyscus* mice (74%) and *T. minimus* (81%) were detected also had evidence of seed predation, but only 33 per cent of stations where *A. california* was detected were there signs of seed predation.

(c) Pinus edulis *seedling recruitment*

Consistent with the difference in animals removing seeds in noisy and quiet areas, *P. edulis* seedlings were four times more abundant on control sites relative to treatment sites ($\beta_{\text{Treatment}} = -1.543 \pm 0.240$ s.e.; figure 3*e*), but number of *J. osteosperma* trees ($\beta_{\text{Juniper}} = 0.036 \pm 0.016$ s.e.) and the proportion of dead organic ground cover ($\beta_{\text{Dead}} = 0.023 \pm 0.008$ s.e.) had small, positive effects on seedling abundance (Poisson GLMM: $\chi_3^2 = 38.583$, $p < 0.001$). However, neither of these variables, nor number of *P. edulis* trees, differed between treatment and control sites (juniper LMM: $\chi_1^2 = 0.726$, $p = 0.394$; dead ground cover LMM: $\chi_1^2 = 0$, $p = 1.0$; *P. edulis* LMM: $\chi_1^2 = 2.560$, $p = 0.110$), suggesting that other habitat features can be excluded as alternative explanations for *P. edulis* seedling recruitment on treatment and control sites.

4. DISCUSSION

Elevated noise levels affected pollination rates by hummingbirds and *P. edulis* seed dispersal and seedling recruitment, but the direction of each effect was different. Noise exposure had an indirect positive effect on pollination by hummingbirds, but an indirect negative effect on *P. edulis* seedling establishment by altering the composition of animals preying upon or dispersing seeds. These results extend our knowledge of the consequences of noise exposure, which has primarily focused on vocal responses to noise [8,34,35], somewhat on species distributions and reproductive success [7,10,32,36] and very little on species interactions [7,14–16]. In an example of the latter, traffic noise negatively affects bat (*Myotis myotis*) foraging efficiency by impairing its ability to locate prey by listening to sounds generated from prey movement [14]. Here, our data demonstrate that the frequency of species interactions can change without a direct effect of noise on the interaction itself, suggesting that noise exposure may trigger changes to numerous ecological interactions and reverberate through communities.

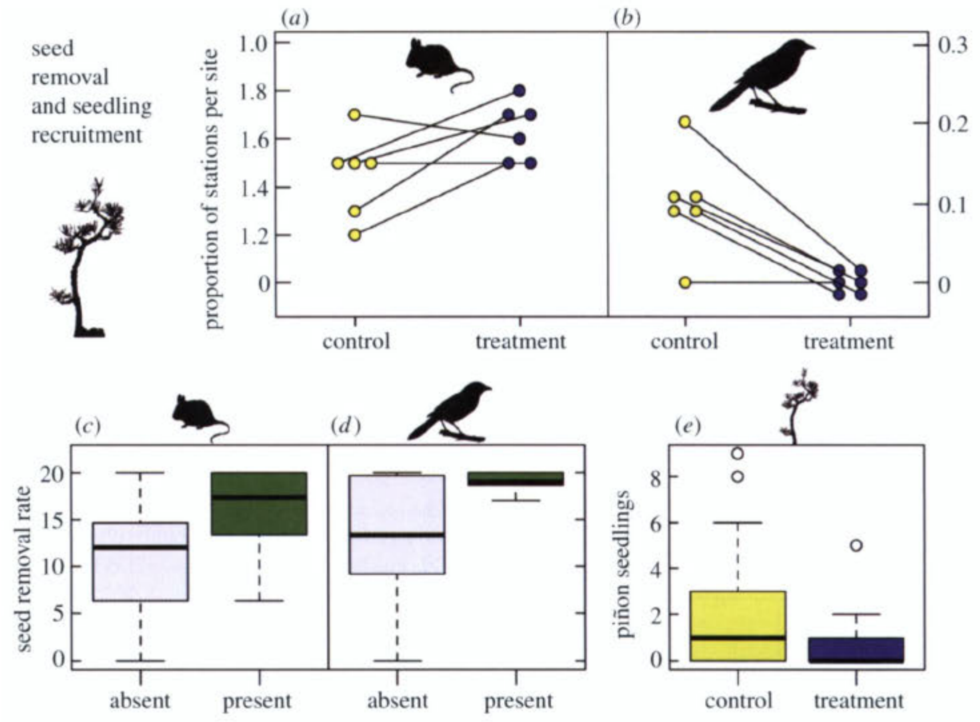

Figure 3. (*a*) *Peromyscus* mice were detected more frequently at treatment seed stations relative to control stations. (*b*) *A. californica* removed seeds exclusively on control sites. Values displayed in (*a*) and (*b*) reflect the proportion of seed stations per site where mice or jays were detected. (*c*,*d*) Seed removal rates (per 24 h) were higher when (*c*) *Peromyscus* mice or (*d*) *A. californica* were detected at a seed station. (*e*) *Pinus edulis* seedling recruitment was significantly higher on control sites relative to treatment sites. Box plots indicate the median value (solid black line), 25th and 75th percentiles (box), and whiskers denote 1.5 the interquartile range. Outliers are denoted by open circles.

Increases in pollination rates were in line with our prediction based on the positive responses to noise by *A. alexandri*, both in terms of nest-site selection [7] and abundances determined from surveys [17]. Our experimental design and use of artificial flowers were advantageous because we could control for variation in density and the spatial arrangement of nectar resources that can influence pollination patterns [37]. However, this approach precluded us from determining whether increases in pollination in noisy areas results in greater seed and fruit production. This is probable for *I. aggregata* because it can be pollen limited throughout its range [38–40] and fruit set is strongly correlated with pollinator (e.g. hummingbird) abundance [18]. Therefore, noise-dependent increases in *A. alexandri* abundances [7,17] coupled with increases in visits to artificial flowers in this study is suggestive that *I. aggregata* plants exposed to elevated noise levels may have greater reproductive output relative to individuals in quiet areas.

Seed removal, seed predation and seedling recruitment data were consistent with one another and our expectations, suggesting that noise has the potential to indirectly affect woodland structure. It is plausible that the suite of species removing seeds may differ in June and July when we conducted our study from that found in the autumn when seeds are typically available. Yet, all species documented removing seeds are year-round residents and their relative abundances are unlikely to fluctuate between treatment and control sites throughout the year. Instead, it is more likely that we underestimated the magnitude of the difference in seed dispersal quality between noisy and quiet areas for two main reasons. First, because *A. californica* typically provision young with protein-rich animal prey [41], individuals at our study area may have been foraging primarily on animal prey rather than *P. edulis* seeds during our experiments. Second, our use of seed stations on the ground did not account for seed removal from cones in the canopy by other important seed dispersers, such as *Gymnorhinus cyanocephalus* (piñon jay); a species that occurs in RCHMA, but also avoids noisy areas [7,42]. The degree to which these factors contribute to reduced seedling recruitment in noisy areas is unknown, but provides an interesting avenue of research for future study.

Although, *A. californica* and *Peromyscus* mice had the greatest influence on seed-removal rates, we were unable to track the fate of individual seeds. Nevertheless, these species influenced patterns of seed predation in a manner consistent with knowledge of how these species differ as mobile links for *P. edulis* seed dispersal and seedling establishment. Evidence of seed predation was less common at seed stations visited by *A. californica*, potentially reflecting its role as an important disperser of *P. edulis* seeds. For example, one *A. californica* individual may cache up to 6000 *P. edulis* seeds in locations favourable for germination during a single autumn [43]. Many seeds are relocated and consumed, but many go unrecovered and germinate [20]. By contrast, although *Peromyscus* mice might function as conditional dispersers under some circumstances [44,45], here their presence at a seed station was a strong predictor of seed predation, reflecting their primary role as seed predators [20]. Previous research using experimental enclosures to study caching behaviour in the field supports our findings [29,44]. *Peromyscus* mice consume a large proportion (approx. 40%) of encountered seeds and typically cache

many encountered seeds that are not immediately consumed [44]. Yet, cached seeds are often recovered and eaten (greater than 80%) along with seeds cached by other individuals or species [29]. Thus, the reduced density of seedlings in noisy areas could be explained not only by fewer seeds entering the seed bank as a result of reduced densities of important avian seed dispersers that cache many thousands of seeds, but because seeds present within the seed bank experience elevated rates of predation via cache pilfering associated with noise-dependent increases in *Peromyscus* mice.

Despite the concordance between our findings and the literature regarding the roles of *A. californica* and *Peromyscus* mice on *P. edulis* seed dispersal and predation, seedling mortality caused by key seedling predators, such as *Odocoileus hemionus* (mule deer) and *Cervus canadensis* (elk), could potentially explain the higher density of seedlings in quiet relative to noisy areas. However, ungulates such as *C. canadensis* appear to avoid areas exposed to noise from high traffic volume [46], suggesting that seedling mortality owing to browsing ungulates should be greater in areas with less noise and leading to a pattern opposite from that which we observed. Still needed are confirmatory studies that track the fate of cached seeds and document patterns of seedling predation within noisy and quiet areas.

Despite the downstream consequences of species-specific response to noise exposure, the mechanistic reasons for species-specific responses are still not clear. *Aphelocoma californica* may avoid noisy areas because noise can mask their vocal communication. Larger birds with lower frequency vocalizations are more sensitive to noise than smaller species with higher frequency vocalizations because their vocalizations overlap low-frequencies where noise has more acoustic energy [17]. *Aphelocoma californica* is also the main nest predator in the study area [7,16] and it is possible that noise masks acoustic cues used to locate prey at nests (e.g. nestling and parent calls). It is also possible that these forms of acoustic interference may lead to elevated stress levels that could influence patterns of habitat use [13], but research on this potential link is currently lacking.

In contrast to the direct effect noise may have on *A. californica* communication and foraging, positive responses to noise by *A. alexandri* and *Peromyscus* mice probably reflect indirect responses to noise. Noisy areas may represent refugia from predators and key competitors that typically avoid noisy areas, including jays. For example, *A. alexandri* may preferentially settle in noisy areas in response to cues indicative of lower nest predation pressure from *A. californica*. Similarly, *Peromyscus* mice populations may increase in noisy areas not only because of reduced competition with *A. californica* and other jays for key-foraging resources, but also in response to reduced predation by nocturnal acoustic predators that may avoid noise [14], such as owls.

That noise may alter patterns of seedling recruitment adds important insights to our earlier work where we found neither *P. edulis* tree density, nor 12 other habitat features differed between treatment and control sites [7]. This, however, may be slowly changing. Reduced *P. edulis* seedling recruitment in noisy areas may eventually translate into fewer mature trees, yet because *P. edulis* is slow growing and has long generation times [47], these initial changes in stand structure could have gone undetected for decades. Such long-term changes may have important implications for the woodland community as a whole by prolonging the negative consequences of noise exposure. That is, noise may not only result in large declines in diversity during exposure by causing site abandonment or reduced densities by many species [7,10], but diversity may suffer long after noise sources are gone because fewer *P. edulis* trees will provide less critical habitat for the many hundreds of species that depend on them for survival [48].

These separate experiments highlight that noise pollution is a strong environmental force that may alter key ecological processes and services. Over a decade ago, Forman [4] estimated that approximately one-fifth of the land area in the United States is affected by traffic noise, yet the actual geographical extent of noise exposure is undoubtedly greater when other sources are considered. Additionally, this spatial footprint of noise, the anthropogenic soundscape, will only increase because sources of noise pollution are growing at a faster rate than the human population [3]. These data suggest that anthropogenic soundscapes have or will encompass nearly all terrestrial habitat types, potentially impacting innumerable species interactions both directly and indirectly. It is critical that we identify which other functionally unique species abandon or preferentially settle in other noisy areas around the world. Early detection of altered species distributions and the resulting disrupted or enhanced ecological services will be key to understanding the trajectory of the many populations and communities that outwardly appear to persist despite our industrial rumble.

This study was completed in compliance with the University of Colorado Animal Care and Use Committee.

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Chapter 1: Introduction: Research and perspectives on the study of anthropogenic noise and birds

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CHAPTER 1

INTRODUCTION: RESEARCH AND PERSPECTIVES ON THE STUDY OF ANTHROPOGENIC NOISE AND BIRDS

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Welcome to the *Ornithological Monographs* volume focused on how anthropogenic noise affects both birds and the study of birds. Concomitant with the growth of human populations and infrastructure development that has left few landscapes untouched by human activities (Ellis and Ramankutty 2008), there has been an increase in anthropogenic noise that emanates from urban areas, as well as from industrial agriculture, resource extraction activities, and our dendritic transportation networks (Barber et al. 2010). Although the negative effects of anthropogenic noise on humans are fairly well documented (e.g., Alberti 1998, Babisch 2003, Jarup et al. 2008), only recently have biologists recognized that anthropogenic noise represents a serious concern for other species as well. Several recent reviews have highlighted potential and known effects of noise on terrestrial organisms (Patricelli and Blickley 2006, Warren et al. 2006, Slabbekoorn and Ripmeester 2008, Barber et al. 2010, Kight and Swaddle 2011); the present volume is the first compilation specifically focused on this important conservation issue.

Born of a symposium on the effect of anthropogenic noise on birds and bird studies at the 2008 Joint Meeting of the American Ornithologists' Union, Cooper Ornithological Society, and Society of Canadian Ornithologists, this volume represents an effort to bring increased awareness to the issue as well as highlight diverse and interesting research in this area of study. In 2008, organizers at that symposium had difficulty locating enough North American investigators studying the effects of noise on birds to fill all the speaking slots. Now, just a few years later, there would be no such problem; the body of studies involving noise and birds has quickly expanded (Fig. 1) and includes a diversity of species, environments, and noise types. Illustrative of the growing interest in this topic, in 2008 we knew of only four urban-adapted songbirds that have distinctly different singing behavior in noisy areas than in quiet areas (e.g., Slabbekoorn and Peet 2003, Brumm 2004, Fernández-Juricic et al. 2005, Wood and Yezerinac 2006, Fuller et al. 2007). This list has now grown to comprise more than 25 species, including suboscine (suborder Tyranni; Francis et al. 2011b) and nonpasserine species (family Psittacidae; Hu and Cardoso 2010) that are found in both urban and nonurban environments. The individual contributions in the present volume further our knowledge of how noise affects bird communication, and they also address other important issues and consequences associated with noise exposure that have received less attention.

One goal in putting together this *Ornithological Monograph* was to provide an overview of this emerging subfield and present a road map for future research. To this end, the review presented by Ortega (2012) describes the history of studies on the influence of noise on birds, presents a brief primer on how noise is measured, and discusses the many ways in which noise can affect birds. Ortega concludes by presenting several areas in need of future research. This review is a good starting place for people who are unfamiliar with the issues surrounding noise and birds or for those interested in pursuing future studies on this topic.

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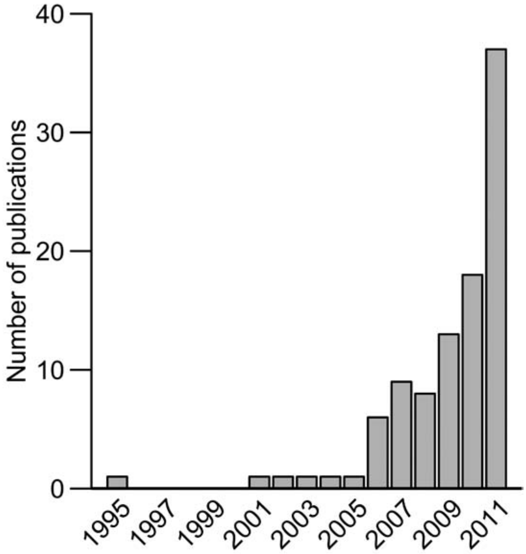

FIG. 1. Results from a Web of Science (Thomson Reuters) search for "bird*noise" and "anthropogenic or urban" conducted on 22 December 2011.

Another goal in compiling this volume was to highlight new, innovative research on the topic. Therefore, the remaining papers present original research on how noise influences avian communication, behavior, habitat selection, and reproductive success and address how noise might hamper investigators' ability to study birds. Although the studies included here represent a fraction of current studies on these topics, they were selected for this volume because they employ a variety of experimental and observational approaches, include a diverse range of species, and address the issue at different scales, from individual behavior to community-level processes.

Birds use acoustic communication for a host of biologically important functions, so it is no surprise that acoustic masking of vocal signals by noise has been cited as a potentially critical problem for a variety of species (Patricelli and Blickley 2006, Francis et al. 2011a). Four contributions to this volume present research related to acoustic communication, each providing a unique and needed perspective. In the first, Blickley and Patricelli (2012) provide an overview of how anthropogenic noise can mask acoustic signals and result in a communication breakdown along three separate stages of the interaction between a signaler and a receiver: detection, discrimination, and recognition. Their analyses demonstrate that low-frequency noise from energy extraction activities masks the acoustic display of lekking male Greater Sage-Grouse (*Centrocercus urophasianus*), greatly reducing the distance at which these signals can be detected. Such masking may impair the ability of female Greater Sage-Grouse to assess potential mates, which is critical to the breeding biology of this species of conservation concern.

In another study focused on the effects from energy-sector noise, Francis et al. (2012a) compare habitat use and singing behavior of the Blue-gray Gnatcatcher (*Polioptila caerulea*) and the Spotted Towhee (*Pipilo maculatus*) in response to chronic noise produced by compressors coupled with natural gas wells. Habitat occupancy of both species is uninfluenced by noise, but the Spotted Towhee sings at a higher frequency in noisy areas, whereas the Blue-gray Gnatcatcher does not. This difference in vocal behavior may be explained by the greater masking potential of this low-frequency noise for the lower-frequency towhee songs than for the gnatcatcher songs and is consistent with recent findings comparing frequency change in several species in Australia (Hu and Cardoso 2010).

Using a study system that spans a gradient of urban development, Kight et al. (2012) present findings from playback experiments that demonstrate how noise, physical habitat features, and signal acoustic properties affect sound propagation. They show that anthropogenic noise and human alterations to natural areas can, respectively, reduce the signal-to-noise ratio (which represents the contrast between the signal and background noise) and degrade signal features. Their findings imply that preserving natural features may be just as important as managing noise levels to maintain conditions suitable for bird communication.

Using the same gradient of urban development, Swaddle et al. (2012) focus on parent–nestling communication. Specifically, they examine whether the begging calls of nestling Eastern Bluebirds (*Sialia sialis*) vary with changes in anthropogenic noise exposure and assess how weather conditions affect call propagation distance. They show that nestlings of this species fail to adjust any aspect of their calling behavior in response to increases in noise levels and that increases in temperature and humidity can greatly reduce the distance at which begging signals can be heard. Collectively, these four studies highlight how masking of acoustic communication by anthropogenic noise can influence birds in a

variety of contexts, from mate selection to habitat use and in both urban and nonurban areas.

Just as noise may impair acoustic communication in several species, noise also interferes with the human observer's ability to detect birds during surveys. Ortega and Francis (2012) show that continuous noise can reduce acoustic detection of birds by ~50%, which can lead to biased estimates of species richness and community diversity. Surprisingly, anthropogenic noise that raises background noise levels by only 5–10 dB(A) above fairly quiet ambient levels can result in severely biased estimates. This finding has important implications for the countless bird surveys that are used worldwide to monitor population trends, and the message is clear: the effects of ambient noise levels, whether human-generated or naturally occurring, must be considered very carefully when conducting standard surveys.

Species differ in their response to introduced noise, and understanding the impact of anthropogenic noise in relation to other threats is critical for developing effective management plans for sensitive species. Lackey et al. (2012) examine behavioral responses, territory placement, and reproductive success in the federally endangered Golden-cheeked Warbler (*Setophaga chrysoparia*) in a field experiment that used playback of construction noise. Their results suggest that this species alters neither its territory placement nor its behavior in response to noise playback. Reproductive success also appears to be unaffected by construction noise. These findings suggest that intermittent construction noise may not be among the major threats to Golden-cheeked Warblers. This study also highlights the challenges associated with experimentally introducing noise stimuli. Although it is often difficult to accurately reproduce a real noise disturbance in the field, noise playback is certain to serve as an important tool for identifying and quantifying the effects of noise on wildlife in future noise-related research.

In a final contribution, Francis et al. (2012b) focus on community-level processes by examining nest predation patterns in response to noise generated from gas well compressors. They use motion-triggered cameras paired with artificial nests baited with Japanese Quail (*Coturnix japonica*) eggs to determine which predator species prey upon nests in noisy and quiet areas. Their results confirm patterns of higher nest success for real nests in noisy areas (Francis et al. 2009) but also suggest that lower predation in noisy areas may be due primarily to lower densities of main nest predators, rather than to predators being present but impaired by noise in their ability to locate nests. This study underscores the need to examine the effect of noise on species interactions in order to understand individual species' responses to noise as well as cumulative community-level consequences.

Collectively, these papers provide a snapshot of a topic of major current interest in diverse fields, including conservation biology, behavioral ecology, population biology, and community ecology. In the opening review, Ortega (2012) outlines many areas in need of research, but a few issues stand out as especially important in guiding research questions and study designs aimed to reveal how anthropogenic noise affects birds and other wildlife.

It is often difficult to compare noise impacts across studies because of the many ways in which noise is measured and the sparse descriptions of noise that are frequently published. It is critical that we begin to standardize noise-measurement methodologies so that comparisons across studies can be more meaningful. Until standards are established, investigators must strive to fully describe how the noise stimulus varies temporally, report any amplitude-weighting scale that was applied to measurements, and provide power spectra and spectrograms of noise to illustrate the spectral distribution of acoustic energy. To do so, we biologists need to become more familiar with the variety of measurement devices and metrics available; a recent review by Pater et al. (2009) provides a good starting place for researchers who are new to these tools and techniques.

To develop a broader understanding of noise effects on birds and to predict future impacts, studies must include a more taxonomically diverse collection of species, including both those that thrive in urban settings and others that are known to be sensitive to anthropogenic disturbance. We also currently lack an understanding of how species' responses to noise differ with changes in the frequency, power, and timing of noise-exposure events. For example, some types of noise may compromise acoustic communication, but others may increase stress levels (Kight and Swaddle 2011) or trigger no response at all (e.g., Lackey et al. 2012). Determining which sources of noise are most and least problematic will be key to developing effective conservation measures.

We must also develop an understanding of the mechanisms that underlie responses to noise. Are the observed changes in reproductive success and habitat occupancy due primarily to acoustic masking of vocalizations, as has been frequently hypothesized, or are they associated with other mechanisms such as physiological stress? Are individuals responding directly to noise or indirectly via other social and environmental factors that are also influenced by noise? Answering these questions will require more comprehensive and integrated studies that examine the effects of noise on a range of physiological and behavioral parameters.

Problems associated with anthropogenic noise will only grow as Earth is increasingly dominated by human-altered landscapes (Ellis and Ramankutty 2008, Ellis 2011) and because sources of noise are growing faster than the human population (Barber et al. 2010). We have a lot to learn about how and why birds and other wildlife respond to anthropogenic noise, how responses to noise interact with other types of human disturbances to affect populations, and to what extent effects of noise have cumulative consequences for community-level processes. Disentangling these influences will be a challenge, but we hope that this volume will inspire others to begin their own research efforts aimed at understanding this emerging conservation issue. Ultimately, our ability to comprehend and mitigate the effects of noise on birds may be critical to their ability to survive and prosper in an increasingly human-dominated world.

Acknowledgments

In support of their efforts to coordinate this volume, C.D.F. acknowledges the University of Colorado and the National Evolutionary Synthesis Center (NESCent; NSF EF-0905606) and J.L.B. acknowledges the University of California, Davis. C.D.F. and J.L.B. would also like to thank the many referees that provided helpful comments when reviewing the contributions within this volume.

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Chapter 1: Introduction: Research and perspectives on the study of anthropogenic noise and birds

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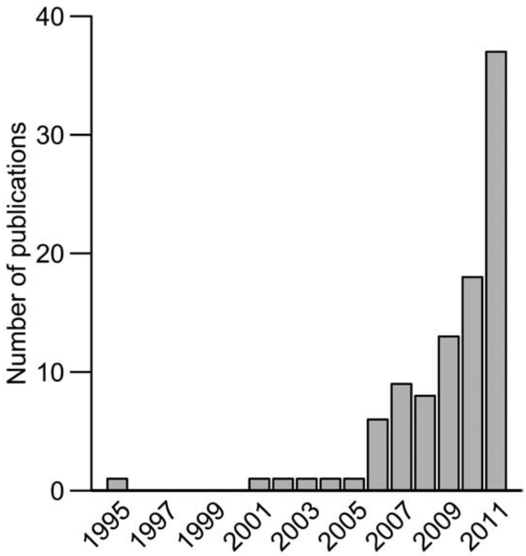

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Vocal traits and diet explain avian sensitivities to anthropogenic noise

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Abstract

Global population growth has caused extensive human-induced environmental change, including a near-ubiquitous transformation of the acoustical environment due to the propagation of anthropogenic noise. Because the acoustical environment is a critical ecological dimension for countless species to obtain, interpret and respond to environmental cues, highly novel environmental acoustics have the potential to negatively impact organisms that use acoustics for a variety of functions, such as communication and predator/prey detection. Using a comparative approach with 308 populations of 183 bird species from 14 locations in Europe, North American and the Caribbean, I sought to reveal the intrinsic and extrinsic factors responsible for avian sensitivities to anthropogenic noise as measured by their habitat use in noisy versus adjacent quiet locations. Birds across all locations tended to avoid noisy areas, but trait-specific differences emerged. Vocal frequency, diet and foraging location predicted patterns of habitat use in response to anthropogenic noise, but body size, nest placement and type, other vocal features and the type of anthropogenic noise (chronic industrial vs. intermittent urban/traffic noise) failed to explain variation in habitat use. Strongly supported models also indicated the relationship between sensitivity to noise and predictive traits had little to no phylogenetic structure. In general, traits associated with hearing were strong predictors species with low-frequency vocalizations, which experience greater spectral overlap with low-frequency anthropogenic noise tend to avoid noisy areas, whereas species with higher frequency vocalizations respond less severely. Additionally, omnivorous species and those with animal-based diets were more sensitive to noise than birds with plant-based diets, likely because noise may interfere with the use of audition in multimodal prey detection. Collectively, these results suggest that anthropogenic noise is a powerful sensory pollutant that can filter avian communities nonrandomly by interfering with birds' abilities to receive, respond to and dispatch acoustic cues and signals.

Keywords: acoustic communication, acoustical environment, foraging ecology, habitat use, novel environments, phylogenetic, sensory ecology

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Introduction

Human activities have appropriated nearly 80% of the Earth's land cover with industrial agriculture, resource extraction, sprawling urban areas and dendritic transportation networks (Ellis, 2011). Because declines in biodiversity in response to these anthropogenic influences are so pervasive (Dirzo *et al*., 2014), there is an urgent need to understand which anthropogenic factors are responsible for declines and what traits make species more or less vulnerable. Anthropogenic noise accompanies nearly all human-induced environmental changes, and few landscapes are untouched by altered acoustics. For example, a recent estimate suggests that over 88% of the contiguous U.S. experiences sound levels elevated due to human activities (Mennitt *et al*., 2013). Given the near omnipresence of this anthropogenic stimulus, plus the importance of auditory systems as a primary sensory modality by which organisms interact with their environment (Bradbury & Vehrencamp, 2011; Stevens, 2013), it is somewhat surprising that our knowledge of how changes to environmental acoustics affect organisms and their supporting ecological systems has only recently gained increased attention by biologists (e.g. Brumm & Slabbekoorn, 2005; Barber *et al*., 2010; Francis & Blickley, 2012).

Anthropogenic noise is, evolutionarily speaking, a feature of the environment that creates novel environmental acoustics for organisms that evolved under quite different acoustic regimes. Birds have been at the forefront of research aimed at understanding how altered acoustics affect freeliving organisms, primarily because they have been viewed as especially sensitive to acoustic environmental pollution because of their reliance on vocal communication (Slabbekoorn &

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Ripmeester, 2008). Most research on this topic has investigated whether birds persist in areas exposed to noise (Bayne *et al.*, 2008; Francis *et al.*, 2009, 2011d) or how birds alter acoustic signals in the evolutionarily novel acoustic environments of cities, roadways and industrialized wildlands (Slabbekoorn & Peet, 2003; Nemeth & Brumm, 2009; Francis *et al.*, 2011b). From these studies, it is clear that many, but not all, species abandon noisy areas. Still unclear is whether the particular characteristics of noise are important in triggering species-specific patterns of site abandonment and *why* some species are sensitive and others are not. For example, are species more sensitive to continuous noise that is typical to industrial areas or noise that is intermittent, which is common along roadways and urban areas? Similarly, do particular species traits predict sensitivity to noise? Are sensitivities influenced by phylogeny?

To date, a limited number of studies suggest that birds are sensitive to noise because it disrupts their vocal communication. Anthropogenic noise is dominated by low-frequency energy that diminishes in strength toward higher frequencies. Given the spectral profile of noise, birds with low-frequency vocalizations may have a greater difficulty communicating than species that communicate at higher frequencies. Indeed, this is what three single studies report (Rheindt, 2003; Francis *et al.*, 2011c; Goodwin & Shriver, 2011). Indirect evidence for this possibility also comes from the observation that species that regularly inhabit urban areas have higher frequency signals than birds that avoid urban areas (Hu & Cardoso, 2009; Cardoso, 2014). Theory also suggests signal redundancy or length should also improve communication in noisy environments (Bradbury & Vehrencamp, 2011); therefore, birds with longer vocalizations or those that signal more frequently may be less sensitive to noise exposure (Table 1).

Species traits unrelated to communication systems might also predispose organisms to be more sensitive to noise (Table 1). For example, nest placement could influence exposure to noise whereby birds that nest within cavities or on or near the ground where noise attenuation is high might be less sensitive to noise (Wiley & Richards, 1978; Swaddle *et al.*, 2012). Foraging location and diet may also play a role. Boundary effects can increase attenuation of low-frequency sounds within a few meters from the ground (e.g. Wiley & Richards, 1978); thus, birds that forage on or near the ground may experience lower sound levels in noisy environments than birds that forage at larger distances above the ground. Additionally, noise has been shown to negatively affect hunting success in fish (Purser & Radford, 2011) and bats (Siemers & Schaub, 2011). Although birds are typically viewed as visual predators (e.g. Cuthill *et al.*, 2005), noise could impair the use of multisensory prey detection and handling via acoustic masking. Consequently, differences in sensitivity to noise may exist between birds that hunt animals that generate sounds and birds that consume plant material (Table 1).

Features specific to individual studies might also influence the strength of responses to noise (Table 1). For example, chronic noise could more severely affect birds via masking of communication than intermittent traffic or urban noise because 'quiet temporal windows' may exist for the latter in which birds can successfully dispatch their signals. Additionally, how investigators measure avoidance of noise could influence the magnitude of a response. Recent research suggests that some species experience reduced pairing success in noisy areas (Habib *et al.*, 2007; Gross *et al.*, 2010). The mechanism responsible for lower pairing success in noise remains to be sorted out (*reviewed in* Francis & Barber, 2013), but has the potential to create a disparity between surveys that count individuals and those that count breeding pairs or number of nests. For example, for a species that has lower pairing success in noise areas, unpaired males occupying territories in noisy and quiet areas are counted using surveys of individuals, but these unpaired individuals would not be considered for protocols in which investigators count the number of breeding pairs or nests. Thus, if a reduction in pairing success is a widespread phenomenon in response to noise, it is possible that responses to noise that quantify breeding pairs or nests are stronger than responses to noise based on counts of individuals.

Here, I seek to understand several gaps in our knowledge involving avian responses to noise, such as how variation in species traits, noise sources and study designs influence sensitivities. Addressing such variation in a single field study would be exceedingly challenging, and few local-scale studies have attempted to understand how many of these features influence responses to noise. Thus, in this study, I adopt a synthetic approach and pair data from 14 published studies reporting avian habitat use in response to road, urban or industrial noise with information on species-specific vocal and ecological traits. I use a phylogenetic comparative framework to evaluate how species traits, different noise sources (i.e., chronic industrial versus traffic or urban noise) and responses measured (i.e., point counts versus counts of breeding pairs or nests) best explain sensitivity to noise (Table 1).

Materials and methods

Responses to noise

Studies used in this analysis were selected in 2011. The primary requirement for inclusion was that each study quantified

Table 1 Hypotheses and predicted effects of variables expected to influence avian use of noisy environments

Variables	Hypotheses	Predicted effect
Vocalizations		
Peak frequency	Higher frequency vocalizations should experience less energetic masking from noise	+
Frequency range	Vocalizations with a broader frequency range may experience more energetic masking from noise than vocalizations with a narrow range, which may have a higher contrast against noise	−
Vocalization duration	Longer vocalizations may be easier for receivers to detect under noisy conditions than short vocalizations	+
Vocalization interval	Vocalizations with long intervals between them may be more difficult for receivers to detect in noise than signals vocalized with short intervals between them	−
Foraging		
Diet	Species that consume animals exclusively may be more sensitive to noise than species that are omnivorous or consume plant material because noise may directly impair their ability to detect and capture prey or indirectly through distraction	−
Foraging location	Species that forage on or near the ground may be less sensitive to noise because vegetation near the ground may attenuate noise more quickly than above ground	−
Nesting		
Nest type	Species with open nests (e.g. cup, saucer, platform) may be more sensitive to noise than species with closed (e.g. cavity, hole) nests, which may be protected from higher noise levels	−
Nest location	Species that nest on or near the ground may be less sensitive to noise because vegetation near the ground may attenuate noise more quickly than above ground	+
Study specific		
Noise type	Continuous industrial noise may more severely impact birds than intermittent traffic and urban noise, which can have quiet temporal windows during which species can communicate or forage	+
Response measured	Responses to noise that measure breeding attempts that reach pairing success or farther in the breeding sequence, in which males have successfully attracted a mate, may appear more negatively impacted by noise than responses measured as abundance of individuals, which could detect many unpaired males defending territories in noisy areas	−

habitat use in response to noise and provided data reflective of habitat use in noisy and quiet locations within the article, as a supplement, or elsewhere (e.g. data repository, thesis). For article selection, because many studies that report avian responses to noise are aspects of road ecology studies, I first reviewed all articles cited by two thorough and recent road ecology reviews (Fahrig & Rytwinski, 2009; Kociolek *et al.*, 2011). I also consulted several reviews on the effects of noise on wildlife (Patricelli & Blickley, 2006; Dooling & Popper, 2007; Slabbekoorn & Ripmeester, 2008; Barber *et al.*, 2010). This collection of reviews produced nine peer reviewed articles that met the criteria. A remaining set of five recent articles that met the criteria described above was also selected because they had cited at least one of the above listed reviews. Finally, a concurrent thorough literature review (e.g. Francis & Barber, 2013) and Web of Science literature search for 'bird*noise' and 'anthropogenic or urban' (see Francis & Blickley, 2012) revealed no additional suitable studies for this analysis.

The data search resulted in quantitative information from 14 studies (Table 2, Table S1) and included 338 observations from 308 populations and 183 species. Eleven of the selected studies focused on responses to urban/traffic noise, which typically varies temporally in several ways (e.g. daily cycles, weekday versus weekend). The remaining three studies measured responses to continuous industrial noise that has little to no variation 24 h per day throughout the year. Eleven of the selected studies included data reflective of the presence or abundance of individuals (e.g. occupancy, density, number of individuals), three studies included data reflective of the number or density of breeding pairs and one included both abundance of individuals and number of nests (Table 2).

Most studies compared responses to noise in a general pairwise fashion (i.e., density or abundance of individuals in quiet versus noisy areas); however, one study used transects oriented perpendicular to roadways, estimating abundance of species at points separated by 100 m (Summers *et al.*, 2011). In order to compare species responses to noise from this study to all other studies using a pairwise design, I used only the data collected at two distances from the roadway: sites located 50 m (noisy) and 450 m (quiet) from the roadway.

To standardize measures of habitat use in response to noise across studies, I calculated the relative strength of each response as the natural logarithm of the ratio of the measurement on noisy sites (e.g. density, abundance, etc.) relative to that on quiet sites (e.g. Davies *et al.*, 2000; Francis *et al.*, 2011c). When a species was undetected on either noisy or quiet sites (~21% of all observations), to permit the calculation of a ratio, I performed a quantitative adjustment by adding one to the value representing use of noisy areas and to the value representing use of quiet areas (Francis *et al.*, 2011c). I also coded each response to reflect whether it was in response to continuous industrial noise or intermittent traffic or urban noise and whether the response reflected the abundance of individual birds (e.g. occupancy, density, abundance), which is not

Table 2 Individual studies included in the analyses are presented in this article. See table S1 for additional information regarding acoustic metrics and distances from noise sources for each study

Noise type	*n*	Location	Study	Measure
Traffic/urban	8	Virginia, USA	Goodwin & Shriver (2011)	Occupancy
	12*	San Juan, Puerto Rico	Herrera Montes & Aide (2011)	Occupancy
	55	Central Finland	Kuitunen *et al.* (1998)	Density
	20	Salamanca, Spain	Peris & Pescador (2004)	Density
	55	The Netherlands	Reijnen *et al.* (1995)	Density
	1	The Netherlands	Reijnen & Foppen (1994)	Density
	28	The Netherlands	Reijnen & Foppen (1995)	Density
	49	Ontario, Canada	Summers *et al.* (2011)†	Abundance
	15	Bavaria, Germany	Rheindt (2003)	Number Breeding Pairs
	10	Madrid, Spain	Fernandez Juricic (2001)	Abundance
	1	Zurich, Switzerland	Gross *et al.* (2010)	Number of Breeding Pairs
Continuous Industrial	23	Alberta, Canada	Bayne *et al.* (2008)	Density & Occupancy
	30	New Mexico, USA	Francis *et al.* (2011a)‡	Abundance
	30	New Mexico, USA	Francis *et al.* (2011a)‡	Number of Nests
	1	Alberta, Canada	Habib *et al.* (2007)	Number of Breeding Pairs

*Denotes reduced due to missingness of life history or vocalization data.
†Data available from Summers, 2009.
‡Abundance of individuals and number of nests were included in the same study.

necessarily indicative of a breeding attempt, or reflected the establishment of a breeding attempt by a pair (e.g. number of breeding pairs, number of nests).

Reporting of background sound levels varied across the selected studies (Table S1). For example, seven studies did not report sound levels for both quiet and noisy sites or only reported values for noisy sites. Acoustic metrics for other studies were either estimated based on propagation models or measured in a variety of manners, and it was not always clear how measurements were obtained. Given the absence of many measurements, plus the heterogeneity and uncertainty among those provided, it was not possible to incorporate measured sound levels into my analyses.

Species Traits

For each species in the dataset, I collected species trait information pertaining to their vocalizations, size, diet and nest placement. Because previous small scale studies have suggested that birds are sensitive to noise based on features of their vocalizations, and specifically vocal frequency (Rheindt, 2003; Francis *et al*., 2011c; Goodwin & Shriver, 2011), I collected information on species specific vocal frequency, but also other vocal features that theory suggests should improve communication in noisy conditions, such as the length of vocalization and frequency bandwidth (Brumm & Slabbekoorn, 2005; Wiley, 2006; Bradbury & Vehrencamp, 2011). Vocalization data for 30 species were obtained from Francis *et al.* (2011a). For the remaining species, I used high quality recordings from audio archives (xeno canto.org) and commercially available audio guides (Elliott *et al*., 1997; Roche, 1997; Stokes *et al*., 2010) (Table S2). Songs were measured from all passerines that sing, and most common calls were used for passerines that do not sing and nonpasserine species. From each recording, I measured five randomly selected vocalizations and measured peak frequency (kHz), which is the frequency at which a species vocalizes at the highest amplitude, vocal frequency range [maximum minus minimum frequency (kHz)], duration of vocalizations (s) and the intervals between vocalizations (s). I measured minimum and maximum frequency using a threshold of −30 dB relative to the peak frequency, which was calculated automatically. All measurements were made using RavenPro 1.4 (Cornell Laboratory of Ornithology, Ithaca, NY, USA) using a temporal and frequency resolution of 5.8 ms and 86.1 Hz, respectively (i.e., a sampling rate = 44.1 kHz with a Hamming window, fast Fourier transformation = 512).

Because vocal attributes can be highly correlated with body size (e.g. Cardoso, 2010; Francis *et al*., 2011c), I obtained species mass from Dunning (2008). Additionally, because noise may not only interfere with communication, but could affect an organism's ability to forage and influence vigilance and sleep patterns (Francis & Barber, 2013), from Ehrlich *et al.* (1988) and Snow & Perrins (1998), I collected categorical information on diet, foraging location and nest type and placement. Diet categories indicated whether a species' diet was animal based, plant based or omnivorous. Foraging location indicated whether a species' primarily foraged on the ground or above the ground (e.g. bark or canopy gleaning, hawking). Nesting information included whether a species nest was open (e.g. cup, saucer, platform, scrape) or closed (e.g. cavity, crevice, hole) and whether it was located on the ground, near the ground (e.g. reeds, shrubs) or above the ground (e.g. canopy, on the wing).

Phylogeny

Song, body size and life history traits are known to have phylogenetic structure where more closely related species are more

similar in size or have more similar vocalizations, diets and nesting behaviors than more distantly related species. To account for relationships among relatedness and trait similar ity, my phylogenetic hypotheses were based on phylogenies developed by Jetz *et al*. (2012) (Fig. 1). Because of the phyloge netic uncertainty in the set provided by Jetz *et al*. (2012), I used 100 randomly chosen phylogenies from the complete set. Addi tionally, to take advantage of multiple responses to noise by the same species, I transformed all phylogeny tips representing taxa with multiple responses into multichotomies (i.e., polyto mies) prior to the analyses using custom R code (r project.org).

Analyses

I used phylogenetic generalized least squares (PGLS) and lin ear mixed effect models (LMM) to predict species responses

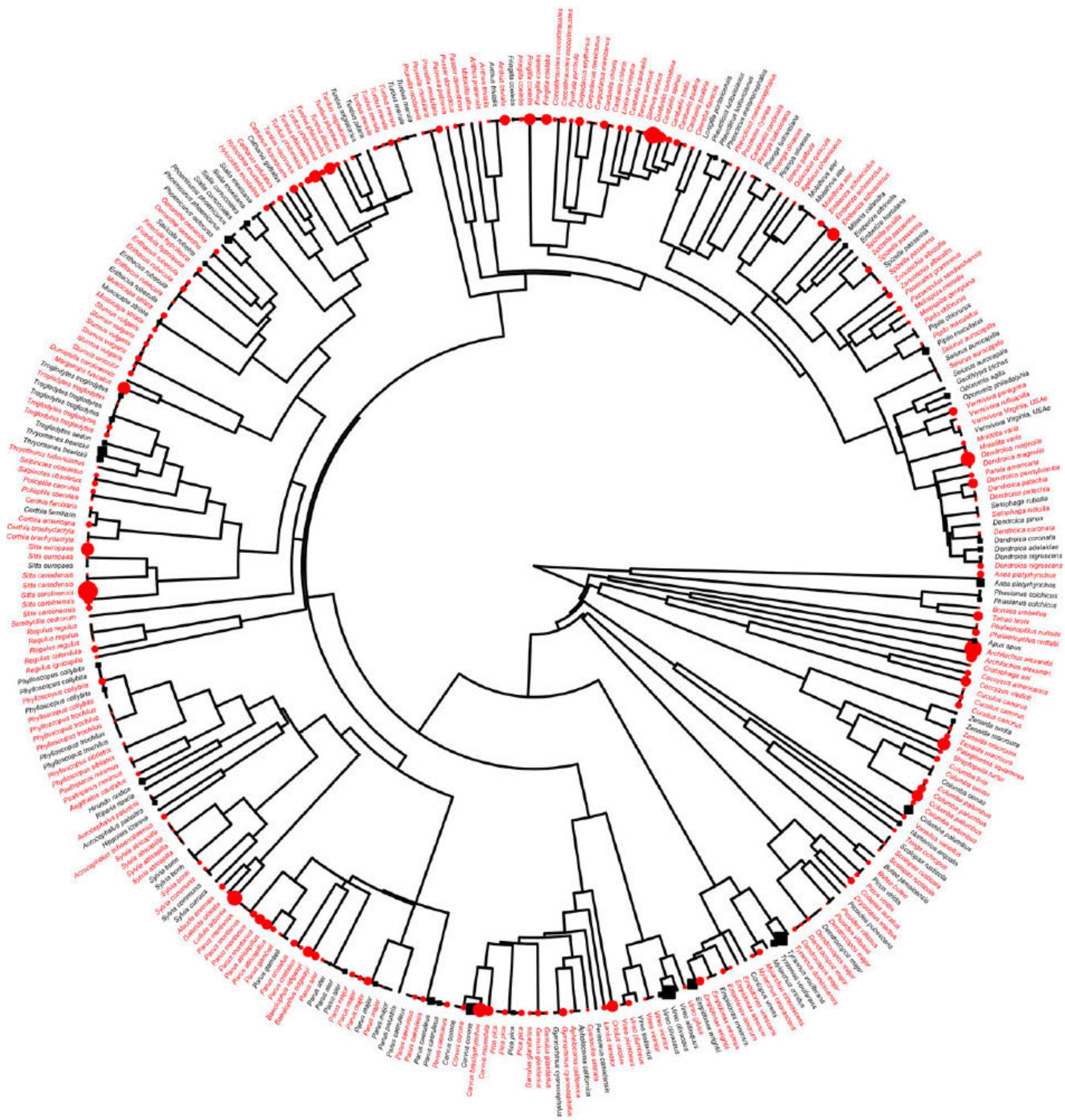

Fig. 1 One of the multichotomy phylogenies used in PGLS analyses. Red circles at the tree tips and red names reflect a negative response to noise, and black square tips and names denote a positive response. Size of circles or squares at the tree tips reflects the strength of the response. All phylogenies are based on trees from Jetz *et al*. (2012) and available at birdtree.org.

to noise using species and study specific information. The PGLS approach accounted for the phylogenetic structure in the models by estimating Pagel's λ (Revell, 2010). High values of λ indicate a strong similarity in the relationship between predictor and response variables for closely related taxa, λ values equal to zero suggest that the predictor response variable relationship is unrelated to phylogeny and negative λ values suggest that closely related species have a negatively correlated predictor response variable relationship. I complemented the approach using PGLS with an analysis using LMM, treating each individual study as a random effect to account for the nested nature of the dataset.

For both approaches, I used an initial global model that included eight species specific variables: peak frequency, frequency range, vocalization length and interval, the natural logarithm of body mass, nest placement, diet, foraging location, plus two study specific variables: response measured (individual abundance versus pairing success) and noise stimulus (continuous industrial versus intermittent urban or traffic noise). I also included an interaction between peak frequency and response measured. I hypothesized that a territorial male's ability to successfully attract a mate, as opposed to mere presence in noisy areas, depends strongly on communication ability, and frequency had been shown to explain responses to noise previously (Francis *et al*., 2011c).

I used an information theoretic approach (Burnham & Anderson, 2002) for my model selection procedure for both the PGLS and LMM approaches. Because I sought to determine which suite of variables across hypothesis categories best explained responses to noise, I iteratively ranked all possible combinations of variables included in the global models using Akaike's Information Criterion corrected for small sample sizes (AIC_c). Competing models were ranked based on differences in AIC_c scores (ΔAIC_c). Models with ΔAIC_c scores within four of the best models were considered to have strong support because those with $\Delta AIC_c \leq 2$ are considered to have substantial support, those where $4 \leq \Delta AIC_c \leq 7$ are considered to have considerably less support and those $\Delta AIC_c \geq 10$ are considered to have no support (Burnham & Anderson, 2004). For all candidate models, I calculated Akaike weights (w_i) to weigh the evidence of importance for each variable included in supported models ($\Delta AIC_c \leq 4.00$). Finally, I used Akaike weights to calculate model averaged parameter estimates, and unconditional 95% confidence intervals (95% CIs) for all variables were included in strongly supported models ($\Delta AIC_c \leq 4.00$). This procedure was completed once for the LMM approach, and 100 times for PGLS models using each of the 100 phylogenies were included in the set. Because model selection and model averaging were completed 100 times with each randomly chosen phylogeny from the Jetz *et al*. (2012) set, weighted parameter estimates resulting from each model averaging procedure were averaged. For both the PGLS and LMM approaches, I concluded that there was evidence for the influence of a single predictor variable on sensitivity to noise when the 95% CIs did not overlap zero.

All analyses were completed in R (r project.org). I used the *nlme* package for PGLS (Pinheiro *et al*., 2012), the *lme4* package for LMM (Bates *et al*., 2012) and the *MuMIn* package for model selection and multimodel averaging (Barton, 2012). Data presented here have been deposited at Dryad (www.datadryad.org; doi:10.5061/dryad.7v6q3).

Results

In general, birds across all study locations responded negatively to noise, but with considerable variation from study to study (Fig. 2).

PGLS models

Strongly supported PGLS models received considerably more support from the data than intercept-only models including phylogenetic structure (ΔAIC_c 33.50; supported models mean AIC_c 657.55; intercept-only mean AIC_c 691.30). Model selection iterations resulted in a median of 4 strongly supported models per model selection procedure with each phylogeny (minimum 1, maximum 34). Although I expected a positive phylogenetic structure for models predicting responses to noise based on species traits (i.e., Pagel's $\lambda > 0$), estimated Pagel's λ values suggested that the relationship between predictor variables and response to noise was slightly negatively correlated (supported models mean λ -0.068 ± 0.049 SD; Table S3). Accounting for this negative phylogenetic correlation in the PGLS models was supported by the data over models that lacked phylogenetic structure (top strongly supported GLS model without phylogeny, AIC_c 678.52).

Among the strongly supported models, only peak frequency, diet and foraging location had strong effects on sensitivity to noise and had mean variable importance scores of 1.0, 0.69 and 0.95, respectively (Fig. 3). Specifically, vocal frequency was positively related to response to noise (β_{Peak} 0.138 ± 0.031 SE, 95% CIs: 0.077, 0.200), as was plant-based diet ($\beta_{\mathrm{Diet\text{-}Plant}}$ 0.202 ± 0.101, 95% CIs: 0.003, 0.400; Fig. 4). Foraging on the ground relative to foraging above ground was also positively related to response to noise ($\beta_{\mathrm{Foraging\text{-}Ground}}$ 0.197 ± 0.090, 95% CIs: 0.021, 0.374).

LMM models

Results from the LMM approach largely supported those revealed through the PGLS approach. The models with strong support were vastly superior to an intercept-only model that only contained study ID as a random effect (ΔAIC_c 26.92 30.92; strongly supported AIC_c 680.59 684.59; intercept-only AIC_c 711.51; Table S4). Similar to the PGLS approach, model-averaged parameter estimates revealed a

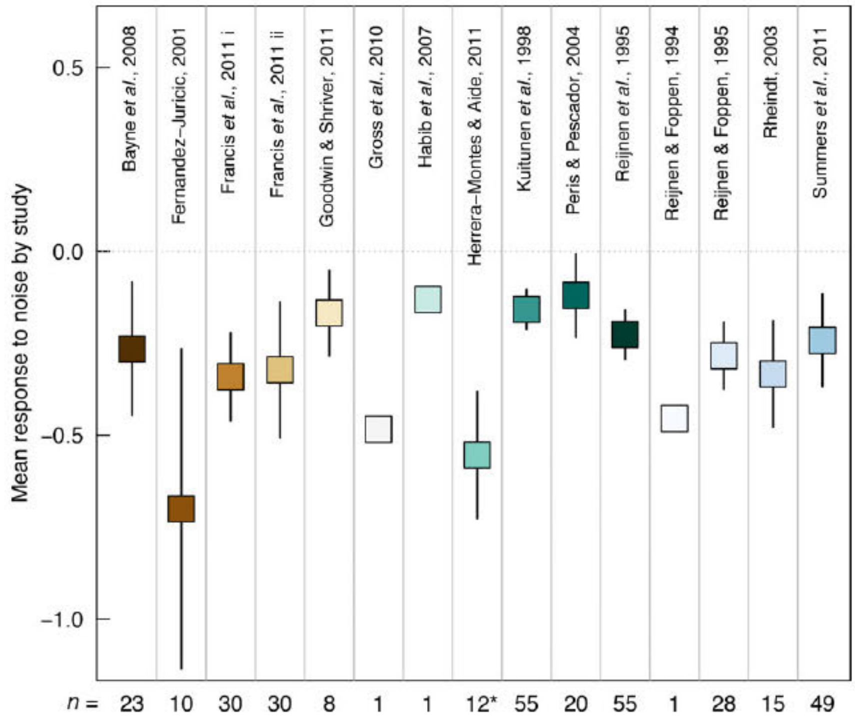

Fig. 2 Mean response to noise for birds included in each study. Error bars denote standard error, and *n* on *x* axis denotes the number of species included in each. Francis *et al.*, (2011a) i and ii refer to the nesting and abundance responses measured in that study, respec tively. * Indicates the number of species included here is reduced from the original dataset due to missing species trait information.

positive relationship between peak frequency and response to noise (β_{Peak} 0.133 ± 0.031, 95% CIs: 0.071, 0.195) and a positive influence of a plant-based diet on response to noise ($\beta_{\text{Diet-Plant}}$ 0.238 ± 0.107, 95% CIs: 0.028, 0.447; Figs 3 and 4). Unlike the PGLS approach, LMM model-averaged estimates did not reveal a positive influence of foraging on the ground on response to noise.

Discussion

Causes of reduced avian diversity in urban and other human-altered environments are varied (Marzluff *et al.*, 2001), and several intrinsic factors have been associated with the ability to persist in these landscapes, such as a broad environmental tolerance, an omnivorous diet, nesting above the ground or sedentary lifestyle (Chace & Walsh, 2006; Bonier *et al.*, 2007; Croci *et al.*, 2008). Here, synthesizing data from 14 small-scale studies distributed across seven countries, I provide evidence for additional intrinsic factors that explain declines in bird populations in these landscapes by evaluating their relevance to persistence in noisy environments. Collectively, this large-scale comparative analysis that pools responses from multiple studies suggest that the presence of noise can play a strong role in determining the distribution of species and nonrandomly filtering communities based on acoustically relevant traits.

Vocal frequency, diet and foraging location appear to influence sensitivity to noise. The role of vocal frequency is supported by several local-scale studies (Goodwin & Shriver, 2011; Proppe *et al.*, 2013), but the influence of diet and foraging location have not been reported previously. Species with plant-based diets appear less sensitive to noise than those with diets partially or entirely based on animals and birds that forage above the ground are more sensitive than those that forage on the ground. These results support my hypotheses, but differ in some ways from results from Cardoso (2014), who found a positive influence of vocal frequency on urban tolerance, but that diet and foraging location, among other life history traits, are unrelated to urban tolerance. Instead, nesting off of the ground was associated with urban tolerance. Probable explanations for the difference include that Cardoso's (2014) study focused broadly on tolerance to urban environments, while the responses measured here were more specifically relevant to noisy environments, whether within or away from urban areas. Additionally, Cardoso (2014) sought to explain diet in terms of generalists (omnivorous) versus specialists (plant- or animal-based diets) rather than evaluating whether

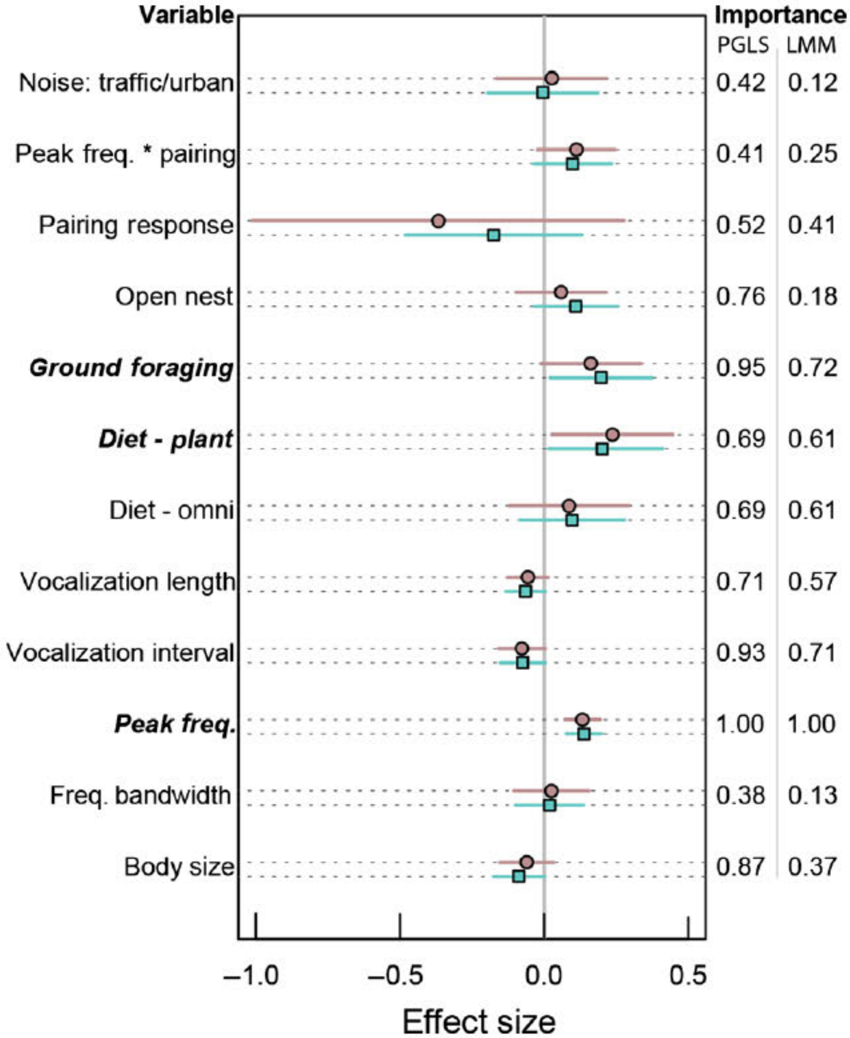

Fig. 3 Model averaged effect sizes for variables included in strongly supported models ($\Delta AIC_c \leq 4$) explaining responses to noise in terms of habitat use. Green squares and lines reflect average estimates from PGLS models, red circles and lines reflect estimates from linear mixed models where lines denote 95% confidence intervals. Strong effects are listed in bolded italic text. Importance reflects the importance of each variable included in strongly supported PGLS (averages) and LMM models ($\Delta AIC_c \leq 4$).

responses differed among birds with plant-, omnivorous- and animal-based diets, and predictions of how foraging modality may be influenced by changes to the acoustical environment by noise. Cardoso (2014) also found an absence of phylogenetic structure in the relationship between urban tolerance and predictor variables. Here, I report λ values that are slightly negative, suggesting that the relationship between the predictors and noise sensitivity has a weak negative phylogenetic correlation. Despite typically high phylogenetic structure for individual vocal and ecological traits (Cardoso, 2014), results from this study and from Cardoso's suggest that sensitivities to noise may not be predictable based on phylogeny alone. Perhaps more importantly, that both studies identified acoustically relevant traits as strong predictors in their models emphasizes the importance of the acoustical environment when understanding ecological response to human-generated global change.

Human-altered environments are often characterized by multiple disturbances, and areas exposed to anthropogenic noise are no exception. Thus, it is possible that declines in response to noise could also reflect responses to other disturbances that covary with noise, such as habitat transformation, the presence of visual stimuli and lights associated with traffic, mortalities due to collisions with vehicles and other confounds (e.g. Summers *et al.*, 2011). However, two pieces of evidence from this synthetic analysis suggest that the responses measured are unlikely to be driven by these confounding variables. First, I found that responses to traffic/urban noise, where noise co-occurs with many

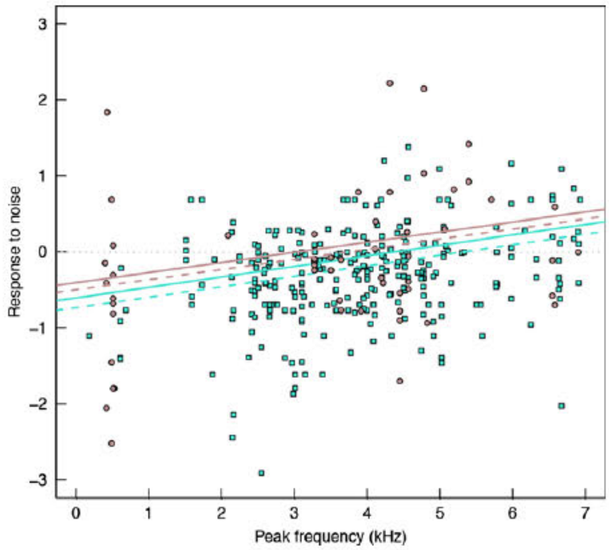

Fig. 4 Response to noise was positively related to peak fre quency of bird vocalizations for birds with plant based diets (red circles and lines) and birds with omnivorous and animal based diets (green squares and lines). Solid lines reflect aver aged coefficients from PGLS models, and dashed lines reflect those for LMMs.

confounding variables, were not different from responses to continuous noise, where, at least for studies included in this analysis, confounding factors were controlled for in their study designs (i.e. Habib *et al.*, 2007; Bayne *et al.*, 2008; Francis *et al.*, 2009). Second, the results support the notion that sensitivity to anthropogenic noise can be explained, at least in part, by vocal frequency a pattern unlikely to result from the influence of confounding stimuli often associated with noise.

Another possible caveat to this study is that sound levels on quiet and noisy areas were not consistent across the included studies. Indeed, of the studies reporting sound levels and the acoustic metric employed, the study with the loudest quiet sites had sound levels that were similar to those measured at noisy sites in other studies (Table S1). Although variation in sound levels across studies most certainly influences the results, and this type of variation is unavoidable when pooling observations from many different studies, the likely outcome is that the strength of relationships between predictor variable and response to noise is underestimated. In other words, the effects documented here are likely conservative. Thus, at least a few traits relevant to the acoustical environment are related to organisms' abilities to occupy noisy areas, and it is likely that other traits and behaviors that are linked to acoustic signaling or signal detection via the auditory sensory modality may prove predictive of sensitivity to changes in global soundscapes. This may be especially true as new information becomes available about responses to noise by other acoustically oriented organisms besides birds.

Disruption of acoustic communication

A large and growing body of research in animal behavior shows that anthropogenic noise presents a serious challenge for acoustically communicating organisms and that many species appear to adjust their vocalizations to better be heard, for example, birds (Brumm, 2004), frogs (Parris *et al.*, 2009), whales (Parks *et al.*, 2007), insects (Lampe *et al.*, 2012). Most known examples document frequency shifts in birds (*reviewed in* Slabbekoorn, 2013) whereby birds located in noisy areas sing at higher frequencies than do conspecifics in quiet areas (e.g. Francis *et al.*, 2011b), or individuals use short-term behavioral adjustments to sing at higher frequencies when exposed to noisy conditions (e.g. Gross *et al.*, 2010). Although the adaptive value of frequency shifts is debated (e.g. Nemeth & Brumm, 2010; Slabbekoorn *et al.*, 2012), adaptive increases in frequency do appear to improve transmission distance (Parris & McCarthy, 2013). Findings from this comparative study also support this growing body of evidence that suggests low-frequency vocalizations are disadvantageous in areas characterized by anthropogenic noise. However, I show that low-frequency vocalizations may be incompatible with noisy environments, forcing many species to avoid or abandon otherwise suitable areas. This too is in line with several local-scale studies reporting that birds with vocal frequencies that can be masked by low-frequency noise tend to avoid noise areas (Rheindt, 2003; Goodwin & Shriver, 2011; Proppe *et al.*, 2013) and by comparative analyses that suggest higher frequency vocalizations are related to urban tolerance (Cardoso, 2014). However, Francis *et al.* (2011c) noted the strong link between body size and vocal frequency could drive body size-dependent habitat filtering by noise, yet in this larger analysis, I found no evidence to suggest that body mass is a strong predictor of response to noise.

A potentially severe fitness consequence for male birds in noisy areas is a reduced ability to successfully attract mates, which has been observed in at least two species; the ovenbird (*Seiurus aurocapillus*) (Habib *et al.*, 2007) and reed bunting (*Emberiza schoeniclus*)(Gross *et al.*, 2010). I found no evidence that studies documenting breeding pairs found stronger negative effects of noise than did those based on counts of individuals. This is perhaps due to the limited number of studies that have measured breeding pairs or nesting attempts. Future field efforts focused on the effects of noise

should emphasize quantifying and comparing the number of breeding pairs and unpaired territorial males with respect to noise exposure to determine whether reduced pairing success could be a widespread fitness cost for males settling and defending territories in noisy areas.

Traffic noise is often thought to have a distinct temporal pattern such that noise levels peak when traffic densities are highest. In contrast to areas exposed to chronic noise, birds near roadways could conceivably adjust the timing of their vocalizations to quieter times to dispatch their signals (e.g. Fuller *et al*., 2007). Ability to signal during quiet temporal windows is one reason birds could be less sensitive to intermittent traffic noise relative to chronic or continuous noise. Contrary to this expectation, however, there was no evidence for a difference in avian responses to intermittent versus continuous noise. Given the overlap in the timing of the dawn chorus and elevated traffic noise levels due to rush hour, this may not be entirely surprising. Two other reasons might also explain why species respond to traffic and continuous noise in similar ways. First, playback experiments targeted at birds that sing during distinct time blocks during the dawn chorus suggest that slight shifts in the timing of signal delivery (*c*. 1 h) can breakdown signaler receiver coordination (Luther, 2008); thus, temporal shifts to capitalize on quiet windows may be ineffective for many species. Second, it is also possible that noise levels at quieter times of the day remain too high for effective communication. In their study involving the effects of traffic noise on great tit (*Parus major*) breeding success, Halfwerk *et al.* (2011) reveal that, at least for their study location in the Netherlands, traffic noise levels can fluctuate much less throughout the day than previously thought. They suggest that this is probably due to less noise produced by individual vehicles during heavy traffic when each vehicle is traveling more slowly than when traffic is light. In effect, the traffic noise levels are high throughout the day, but nights and weekends have lower levels. The precise temporal signatures of background sound levels for the 11 traffic/urban studies included here are not well known because this information was not reported. At best, some studies provided a sound pressure level or a range of values (Table S1). However, insufficient details are provided to know the variability in noise levels at each location.

Disruptions to foraging ecology

To my knowledge, this is the first study to show that diet and foraging location appear to be important predictors of sensitivity to noise. Birds that forage on plant material or those that forage on the ground are less sensitive to noise than species that are omnivorous, those with animal-based diets and those that forage from locations above the ground. It is possible that birds foraging on or near the ground experience lower levels of noise than do birds that typically forage above the ground due to boundary interference or ground effects (Wiley & Richards, 1978), but carefully designed playback studies that evaluate excess attenuation of anthropogenic noise at different distances from the ground are needed for confirmation.

Birds are typically considered visually oriented animals (Cuthill *et al*., 2005; Gill, 2007), yet it is probable that many avian species use multiple sensory modalities when foraging. For example, birds may rely on adventitious sounds generated by moving prey for localization; thus, species with animal-based diets may be more sensitive to noise than those with plant-based diets. However, noise may also serve as a distraction, impair organisms' abilities to process information or increase perceived risk due to impaired auditory surveillance (Chan *et al*., 2010; Francis & Barber, 2013), all of which should affect birds regardless of diet. Existing evidence involving the influence of noise on foraging activities in birds suggests that prey localization and risk assessment may be important. For example, granivorous chaffinches (*Fringilla coelebs*) maintain higher levels of visual vigilance by scanning more frequently and forage less often when exposed to elevated levels of white noise (Quinn *et al*., 2006). Additionally, experimental exposure to broadband white noise reduces hunting success in American robins (*Turdus migratorius*) and Australian magpies (*Cracticus tibicen*) foraging on buried prey (Floyd & Woodland, 1981; Montgomerie & Weatherhead, 1997). Thus, it is possible that both birds with animal- and plant-based diets experience fitness trade-offs between vigilance and foraging that make noisy locations unfavorable; however, those with animal-based diets could also suffer from additional effects due to the masking of auditory cues used in prey detection, localization and capture. Experimental foraging studies are still needed that evaluate whether predominately low-frequency anthropogenic noise has a similar effect on hunting success as broadband white noise and carefully parse the potential roles of antipredator behavior versus prey localization.

It is also possible that the spatial distribution of food resources critical to different foraging guilds could explain the different sensitivities to noise between species with plant-based diets and omnivorous-/animal-based diets. Edge habitat and altered vegetation are signatures of roadways (Forman *et al*., 2003), and it is possible that granivorous species are drawn to noisy roadsides by the nutritional resources provided by shrubs and grasses that often dominate roadsides. This

would not be the case for studies using continuous industrial noise where vegetation features on quiet and noisy sites were similar (e.g. Bayne *et al.*, 2008; Francis *et al.*, 2011c). A *post hoc* analyses for an interaction between noise type and diet did not improve model performance relative to the top LMM model (ΔAIC_c +3.108), suggesting that granivorous and other species with plant-based diets were not more common in areas exposed to high levels of traffic noise. Nevertheless, future studies should attempt to explicitly address the role of confounding variables that might serve to attract some species to noisy areas.

In conclusion, this large comparative study confirms that anthropogenic noise is an important ecological force shaping the distributions of species by disrupting organisms' abilities to interact with the environment acoustically. Continued increases in global anthropogenic noise levels will only make these interactions more difficult by restricting detections of relevant signals to shorter distances and effectively shrinking the perceptual worlds of numerous species. Data presented here will likely prove to be only a small glimpse of how noise and other human-caused sensory stimuli impair organisms' sensory systems. My findings suggest that acoustically related perceptual problems occur for communication and foraging ecology, yet other effects are also likely, such as interference with predator detection, distraction or impaired spatial navigation using phonotaxis (Francis & Barber, 2013). How pervasive the effects are for this understudied global pollutant remains to be seen.

Acknowledgements

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Summary information of studies included in this analysis, including how the study was chosen, the distance of quiet and noisy sites to the noise source, sound levels in decibels (dB) and weighting function, if any, plus the acous tic metric reported. NR, Not reported.
Table S2. Summary information for recordings used in this study to characterize vocalization data.
Table S3. Model averaged parameter results from PGLS analyses across 100 phylogenies tested.
Table S4. Model selection table from linear mixed models for all models with strong support ($\Delta AIC_c \leq 4$), plus the intercept only model including only the influence of indi vidual study as a random effect.

Correction

ECOLOGY

Correction for "Chronic anthropogenic noise disrupts glucocorticoid signaling and has multiple effects on fitness in an avian community," by Nathan J. Kleist, Robert P. Guralnick, Alexander Cruz, Christopher A. Lowry, and Clinton D. Francis, which was first published January 8, 2018; 10.1073/pnas.1709200115 (*Proc Natl Acad Sci USA* 115:E648–E657).

The authors note that on page E651, left column, first full paragraph, line 14, "reviewed in ref. 26" should instead appear as "reviewed in ref. 25."

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CORRECTION

Chronic anthropogenic noise disrupts glucocorticoid signaling and has multiple effects on fitness in an avian community

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Anthropogenic noise is a pervasive pollutant that decreases environmental quality by disrupting a suite of behaviors vital to perception and communication. However, even within populations of noise-sensitive species, individuals still select breeding sites located within areas exposed to high noise levels, with largely unknown physiological and fitness consequences. We use a study system in the natural gas fields of northern New Mexico to test the prediction that exposure to noise causes glucocorticoid-signaling dysfunction and decreases fitness in a community of secondary cavity-nesting birds. In accordance with these predictions, and across all species, we find strong support for noise exposure decreasing baseline corticosterone in adults and nestlings and, conversely, increasing acute stressor-induced corticosterone in nestlings. We also document fitness consequences with increased noise in the form of reduced hatching success in the western bluebird (*Sialia mexicana*), the species most likely to nest in noisiest environments. Nestlings of all three species exhibited accelerated growth of both feathers and body size at intermediate noise amplitudes compared with lower or higher amplitudes. Our results are consistent with recent experimental laboratory studies and show that noise functions as a chronic, inescapable stressor. Anthropogenic noise likely impairs environmental risk perception by species relying on acoustic cues and ultimately leads to impacts on fitness. Our work, when taken together with recent efforts to document noise across the landscape, implies potential widespread, noise-induced chronic stress coupled with reduced fitness for many species reliant on acoustic cues.

acoustic environment | anthropogenic noise | birds | stress response | perceived predation risk

Human made noise is a widespread and complex stimulus that alters habitats, degrades natural acoustic conditions, and partially or fully excludes species that are sensitive to noise exposure from affected areas (1 4). The exact mechanisms by which noise disrupts animals and their environments are still debated, but recent work links noise exposure with alterations in vocalization, vigilance, foraging, and parental behavior (5 12). Despite this recent progress, key questions remain unanswered, especially whether anthropogenic noise represents a chronic stressor for free living animals and the severity of any resulting fitness effects from noise or noise induced stress. Although not unexplored (13 20), the effect of noise on stress and fitness is complex (21). The identification of mechanisms is especially difficult given the possibility that noise could elicit a stress response directly through extreme exposure (22, 23) or indirectly by altering the interaction between animals and their environment (13). Noise levels in wild systems reach the extreme amplitudes that are observed to directly elicit stress responses in laboratory studies [i.e., 90 105 dB (23); 130 dB (24)] only at very close proximity to noise sources. At lower exposure levels, anthropogenic noise is more likely to elicit stress responses indirectly by increasing the difficulty of coping with external challenges (e.g., territory defense) or by creating anxiety through reduced detectability and predictability of threats (e.g., acoustic masking of predator alarm sounds) (8, 24 26), or both. Clarifying the potential impacts of chronic noise exposure in wildlife is timely and needed, given the nearly ubiquitous presence of anthropogenic noise worldwide and the forecasted global rise in noise producing infrastructure (1).

Conservation physiologists often use measurements of an organism's baseline circulating stress hormones, or glucocorticoids (GCs), as an indirect measure of habitat quality and a proxy measure for potential fitness (27). GCs are secreted from the adrenal gland in a coping response to challenge and are the result of activation of the hypothalamic pituitary adrenal (HPA) axis, a chemical cascade triggered by neuronal signals sent from hierarchical neural systems to the hypothalamus in response to the brain's perception of a stressor (28, 29). The HPA axis is a highly conserved vertebrate stress system activated during allostasis, the process by which animals maintain stability, or homeostasis, through change (30). While GCs are modulated in ultradian, circadian, and seasonal rhythms to meet challenges related to predictable energy deficits, frequent disturbance from chronic stressors encountered in low quality habitats can push an

Significance

Studies examining relationships among habitat disturbance, physiology, and fitness in wild animals often produce contradictory or inconclusive results, casting doubt on current conservation physiology predictive frameworks linking stress and fitness. We apply a new framework drawn from experimental systems utilizing chronic inescapable stressors to explore how noise, an environmental stimulus common to wildlife habitats worldwide, disrupts stress hormone signaling and impacts fitness. We utilize a natural experiment to show that chronic, anthropogenic noise reduced baseline corticosterone levels, increased acute corticosterone response, and, at highest amplitudes, negatively impacted multiple measures of fitness across three species of birds. Our work brings conservation physiology theory involving wild animals into needed alignment with recent theories based on chronic stress in laboratory studies.

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organism's physiological state out of the range of a normal allostasis and into a state of allostatic overload. Overload states are often pathological and have been shown to have fitness consequences (30, 31). Although increased allostatic load may suggest higher baseline GCs, the empirical data have been equivocal at best; different studies find decreased as well as increased GCs in response to chronic stressors (17, 25, 32 36).

Baseline corticosterone (hereafter, "cort") levels are generally predicted to positively associate with the intensity of habitat disturbance in what has been dubbed the "cort fitness hypothesis" (21, 27). In contrast to the predictions of this hypothesis, results from laboratory and human systems suggest that exposure to chronic stressors is often associated with decreased basal GC levels, hypocorticism, and GC insensitivity (37, 38). The development of hypocorticism could be a coping mechanism that saves an organism from experiencing the severe effects of allostatic overload (39), but there is evidence that it can lead to reduced fitness. For example, a laboratory based system using mice shows how chronic subordinate social rank triggers hypocorticism, reflected by reduced basal GC levels and GC insensitivity that can be accompanied by an inflammatory response (25, 40) and reduced weight gain (41). Unlike situations in which animals fail to react to repeated chronic stressors, physiological results in this laboratory system are paired with negative fitness outcomes, suggesting that animals do not habituate (42). Additionally, these studies show that individuals experiencing hypocorticism can develop HPA axis sensitivity to heterotypic stressors, leading to increased GC responsiveness following experimental acute stress events (25, 43). In natural systems, such heterotypic stressors could include predation attempts, competitor interactions, or confrontations with humans and other anthropogenic disturbances. While much work has focused on human and rodent laboratory models, the sensory blanketing of the acoustic environment by chronic anthropogenic noise provides a unique opportunity to test if a chronic, inescapable stressor can cause similar stress and fitness responses in wild animals.

The impact of noise is thought to be most severe when frequencies overlap auditory environmental cues, a phenomenon known as "acoustic masking," which leads to reduced detection and discrimination of key acoustic signals and cues. Acoustic signals and cues from both conspecifics and heterospecifics provide important information about the immediate environment, including the quality and location of competitors (44) and the presence or absence of predators through alarm or nonalarm vocalizations and adventitious sounds (45 49). Given the capacity for chronic noise to consistently mask biologically relevant cues (8, 26, 47, 50), animals living in areas with high levels of noise may fail to receive information about their local habitats, leading to a continual state of perceived unpredictability and reduced security (44, 47, 51). The experience of constant environmental uncertainty among both parents and nestlings, whether justified or not (24), could cause chronic activation of the HPA axis and affect both GCs and fitness through reduced hatching success of eggs and provisioning of young (52).

To date, no studies have simultaneously examined relationships among noise, GCs, and fitness in animals that settle and breed in natural areas exposed to chronic anthropogenic noise. To address this significant gap and provide a needed conceptual alignment of recent work in conservation physiology with related work on chronic stress, we performed a natural experiment using wildlands in northern New Mexico's San Juan Basin, where a community of birds breeds along a gradient of noise produced by natural resources extraction (Fig. 1). We measured noise levels, cort, and fitness relevant variables, e.g., hatching success and nestling body condition, in populations of three species of cavity nesting birds with different tolerances to noise: western and mountain bluebirds (*Sialia mexicana* and *Sialia currucoides*, respectively), and ash throated flycatchers (*Myiarchus cinerascens*) (53). We predict that long term exposure to continuous anthropogenic noise will act as a chronic stressor, disrupting GC signaling in adults and nestlings, with the greatest impact at sites with highest amplitude noise. We also predict that long term exposure to continuous anthropogenic noise will be linked to reduced fitness. Incorporating multiple species and disturbance (53 57) into a multiyear study defined by a chronic, homotypic stressor represents the most highly integrated study of the effects of anthropogenic noise on wild birds to date.

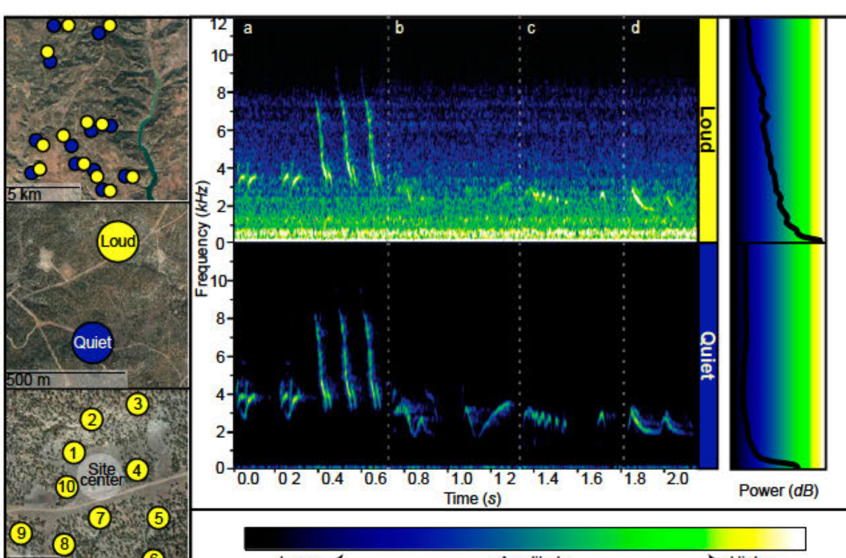

Fig. 1. This conceptual figure shows the study system design and the acoustic properties of sites with and without compressor noise. (*Left*) The three nested spatial scales included in the study: the full system (*Top*), loud and quiet pairs (*Middle*), and individual sites (*Bottom*). The *Bottom* shows nest boxes (labeled 1 10) arrayed around the site center, which was the centroid location of a well pad. (*Center*) A spectrogram of recorded background noise at a louder area (*Upper*) and quieter area (*Lower*). The songs of four common species that are found in RCHMA, including representatives from this study are included to depict the masking potential of noise: (*a*) spotted towhee; (*b*) plumbeous vireo; (*c*) ash throated flycatcher; and (*d*) western bluebird). (*Right*) Power spectra that show the amplitude or "power" of compressor noise at frequencies between 0 and 12 kHz.

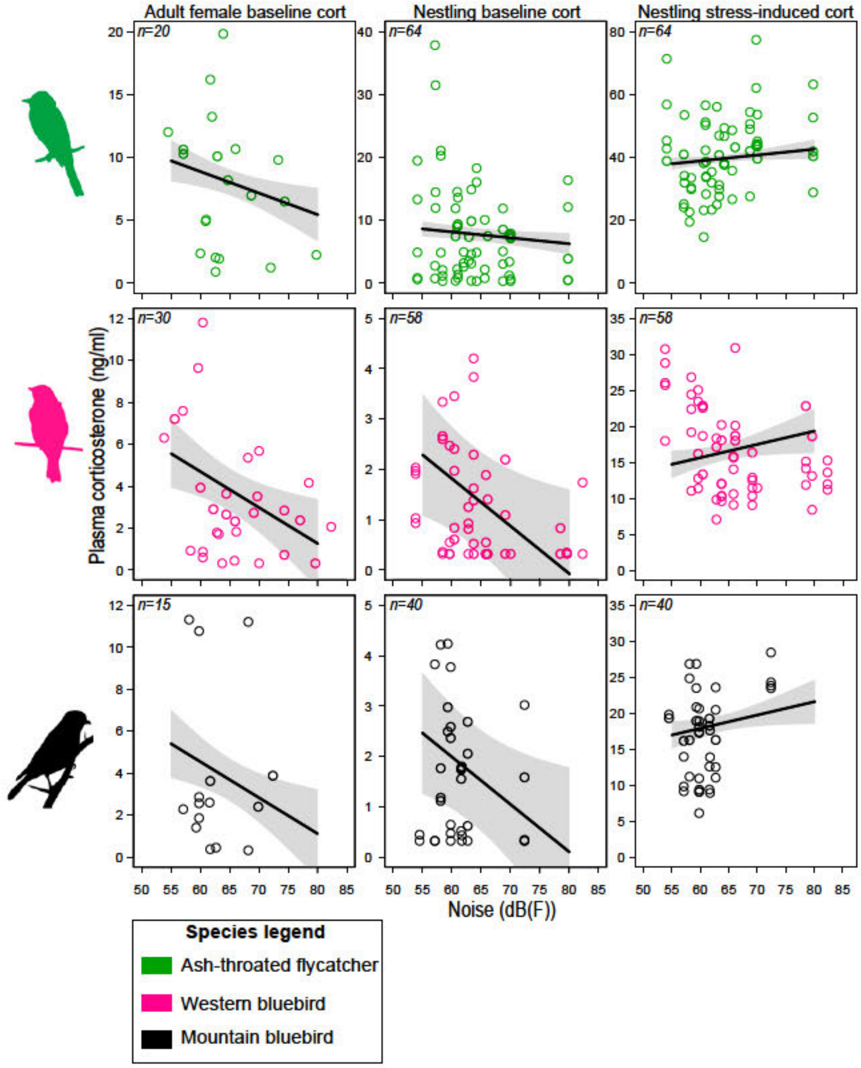

Fig. 2. The graph shows the relationship between cort and noise in all three species and two life stages. Baseline cort levels for both adults and nestlings were negatively affected by noise (*Left* and *Center Columns*, respectively), while acute stress induced cort levels in nestlings were positively affected by noise (*Right Column*). For each model, the effect of noise was consistent across species, irrespective of species specific cort levels. The gray shaded areas indicate the 85% CIs for each estimated effect.

Results and Discussion

Effect of Noise on Cort. The amplitude of compressor noise, measured as equivalent continuous sound level (L_{eq}, dB un weighted [dB(F)]), had a negative effect on baseline cort levels in adult females [linear mixed model (LMM), Gaussian distribution, $\beta_{noise} = -1.120$, 85% CI: −1.966 to −0.279] (Fig. 2 and Table 1). This result, which was consistent across species, supports our prediction that chronic anthropogenic noise exposure is an explanatory factor affecting GC signaling. The finding of a negative linear relationship between noise disturbance and baseline cort strongly suggests that suppression of baseline cort occurs in response to the acoustic dis turbance gradient. While it remains possible that individual GC re sponsiveness affects nest site selection, we do not find any evidence of self sorting based on other quality factors, e.g., body size (Table S1). This relationship is best explained by the development of hypocorti cism, a physiological condition consistent with exposure to chronic stress (25, 39, 40). A previous study found that an experimental chronic stress protocol reduced baseline cort levels among wild breeding female European starlings (*Sturnus vulgaris*) relative to in dividuals in a control group (32).

Nestlings in our study also showed reduced levels of baseline cort with increased noise levels, and, as in adults, there was support for a common effect across species (LMM, Gaussian distribution, $\beta_{noise} = -0.660$, 85% CI: −1.243 to −0.080) (Fig. 2 and Table 1). A comparable result was found in a small scale experimental study that reported reduced baseline cort in white crowned sparrow (*Zonotrichia leucophrys*) chicks exposed to noise during their first 5 d of life (17). That we find a clear negative effect on cort across a gradient of noise in females and nestlings from three different species strongly suggests that chronic anthropogenic noise induces stress and hypocorticism in birds.

Research from the field of sensory ecology demonstrates how masking of critical acoustic communications by chronic noise could lead to stress. The distance over which birdsong and other sounds are effectively transmitted, their "active space" (58), is significantly re duced by increases in ambient background noise (1, 8, 59 61). An thropogenic noise, acting as an acoustic blanket, can reduce or inhibit detection of hetero (46 48) and conspecific (62) vocalizations that birds and other animals (45) use to gain information about preda tion threats. For example, the presence of birdsong and chatter is thought to signal the absence of nearby predators (49, 63). Thus,

Table 1. Effects of noise and other variables on cort and fitness

Dependent variable	N	Fixed effects	Random effects	k	R^2	AIC_c	Null AIC_c	χ^2
Cort predicted by noise								
Adult baseline cort	65	Noise*	Site	8	0.592	369.801	381.857	<0.001
		Species*	Nest ID					
		Life stage*						
Nestling baseline cort	162	Noise*	Year	6	0.319	978.299	1,030.426	<0.001
		Species*						
Nestling acute stressor induced cort	161	Noise*+	Nest ID	9	0.766	1,134.000	1,202.198	<0.001
		Species*						
		Chicks*+						
		Time*						
		Tree cover*+						
Fitness predicted by noise								
All species hatch success	364	Intercept	None	1	0	218.722	Na	Na
Western bluebird hatch success	133	Noise*	None	3	0.039	89.489	91.538	0.045
		Tree cover*+						
Ash throated flycatcher hatch success	138	Noise*+	Year	3	0.024	75.027	75.280	0.126
Mountain bluebird hatch success	93	Intercept	None	1	0	56.586		Na
Nestling feather growth (PC1)	272	$Noise_{quad}$*	Year	9	0.907	295.644	353.080	<0.001
		Species*	Nest box					
			Nest ID					
Nestling body size (PC2)	272	$Noise_{quad}$*	Nest ID	10	0.739	309.872	364.547	<0.001
		Species*						
		Chicks*						
		Distance*						
		Lay date*						

All models presented are best performing models. The term for life stage is included as the effect of the provisioning stage on the dependent variable. The term "distance" refers to the distance in meters from the nest box to the well pad center or compressor station. Models that do not include random effects were run as GLMMs following our described methods. k, parameters estimated; Na, not applicable.

*Predictors that do not include zero in their 85% confidence limits; all continuous predictors are marked with the direction of their effect on the dependent variable.

hearing birdsong could be used as a safety signal in birds, and continual masking could chronically impair risk perception, leading to environmental uncertainty and activation of the stress response. While birds are away from the nest on foraging trips, noise throughout the territory (53) could decrease hunting efficiency (7, 50), reducing energy intake and leading to increased allostatic load relative to individuals in quieter territories. Unlike adults, nestlings are incapable of escaping nest boxes and are constantly exposed to noise. This chronic, inescapable disturbance could stimulate stress and hypocorticism in nestlings through reduced reception of het erospecific (48) or parental (64) cues. Alternatively, the effect of compressor noise on parental vocal behavior (65) could interact with the effects of masking and lead to reduced detectability and increased uncertainty about environmental risk. Provisioning behavior could also be negatively affected by noise, leading to increased allostatic load in nestlings, discussed more below.

We also tested if, as in other systems, responses to acute stressors in animals under chronic stress were higher when ex posed to heterotypic stressors. We measured cort levels in nestlings 10 min after capture and fit models similar to those for baseline measurements. The model with a common effect for noise but with species specific differences best explained acute stressor induced cort levels in nestlings. In contrast to baseline cort results, the effect of noise on acute stressor induced cort was positive (LMM, Gaussian distribution, $\beta_{noise} = 1.297$, 85% CI: 0.067 2.538) (Fig. 2 and Table 1). The finding of suppressed baseline cort and increased acute stress induced cort is consis tent with many laboratory studies on model species, which sug gest that hypocorticism results from chronic psychological stress (reviewed in ref. 26). Sensitization of cort response to acute stressors following exposure to a chronic stressor has also been found in nestling European starlings exposed to a chronic psy chological stress protocol (32) but not in wild caught adult birds exposed to a similar treatment in a laboratory setting (33). This response could be adaptive in nestlings experiencing increased perceived predation risk, as a heightened reactivity during this stage could prime them for more efficient escape effort (66). However, early fledging might trade off with the accumulation of body mass, which can reduce the probability of postfledgling survival (67 69). Although hypocorticism has been proposed as a protective response to increased allostatic load that might allow affected individuals to avoid the most serious effects of overload states (39), the attenuation of baseline cort is also potentially harmful and has been associated with inflammation, disease susceptibility (25), anxiety (43), and reduced exploration of novel objects (70). Thus, studies that explore hormone signaling and survivorship of individuals are necessary to fully quantify the costs of these responses to noise.

Effect of Noise on Fitness: Hatching Success. We found that a sum mary model including all species yielded uninformative results, and we therefore present species specific models for hatching success (Table 1). Results from these models suggest that hatching success was significantly affected by noise in one species, the noise tolerant western bluebird (53). In support of our prediction that increased noise would lead to decreased fitness, hatching success in the western bluebird was negatively associated with noise levels at the nest box [generalized linear mixed effect model (GLMM), binomial distribution, $\beta_{noise} = -0.483$, 85% CI: −0.892 to −0.075] (Fig. 3 and Table 1). Egg hatching rates in ash throated flycatchers showed a weak, positive relationship with noise (GLMM, binomial distribution, $\beta_{noise} = 0.658$, 85% CI: 0.036 1.376) (Table 1), but this model was indistinguishable from the null hypothesis [change in corrected Akaike information criterion (ΔAIC_c) = 0.25]. Similarly, there was no clear effect of noise on hatching rates in mountain bluebirds. Overall, results from all three species may be best explained by previously described nesting patterns.

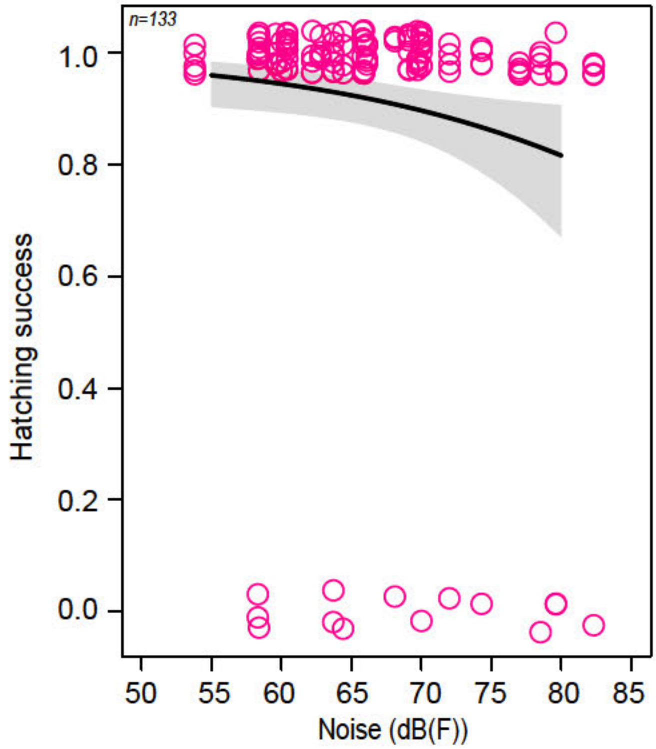

Fig. 3. Hatching success in the western bluebird was negatively affected by noise. The gray shaded area indicates the 85% CI.

The negative relationship between anthropogenic noise and hatching success in western bluebirds represents the strongest effect of noise on a direct measure of reproductive success in this study and is somewhat surprising, given previous results from this system that showed an even distribution of western bluebird nests across the noise gradient (53). The most parsimonious explanation is that the western bluebird may be caught in an equal preference ecological trap driven by anthropogenic noise. An equal preference trap occurs when a species shows equal preference for low and high quality habitats but incurs a reproductive cost in low quality habitats (71). Both the ash throated flycatcher and the mountain bluebird have been shown to avoid noise (53) and appear to escape the negative effects on hatching success related to high amplitude noise exposure. That these population level consequences were not indicated by occupancy data illustrates the importance of studies that combine occupancy, physiology, and fitness data.

One possible mechanism leading to reductions in hatch success is increased distraction and vigilance behavior in areas exposed to higher levels of noise, an effect well documented in the literature among birds, mammals, and arthropods (7, 50, 72 74). During the incubation period, increased vigilance by females could contribute to reduced hatching by a trade off with incubation time leading to fluctuations of nest temperature and reduced time at optimum temperature (75, 76). Increased perceived predation risk has been shown to elevate vigilance via increased nest attentiveness among several bird species; however, this appears to come at the cost of reduced hatching success (52). Other possibilities include noise leading to a breakdown in courtship and copulation, or males, in contrast to females, might sort themselves by quality with noise, potentially leading to low virility males in loud areas. Studies that investigate incubation rates and rhythms, courtship, nest attentiveness, and male quality in the context of noise are still needed to more conclusively determine causes of reduced egg hatching in loud areas. Nevertheless, regardless of the mechanisms involved, our results suggest that noise decreases a direct measure of fitness, hatching success, in the western bluebird, a species previously thought to be noise tolerant.

Effect of Noise on Fitness: Feather Development and Body Size. The effect of noise on fitness may manifest not only in hatching failures but also in reduced body condition of hatched chicks. Development and growth during the nestling stage is an important predictor of juvenile survival and thus acts as a useful surrogate to infer fitness potential in individuals exposed to noise (77, 78). We evaluated the effect of noise on nestling feather growth [principal component feather ($PC_{feather}$)] and nestling body size [principal component size (PC_{size})] (see Table S2 for loadings) in a model including all species. Noise exposure was easily the strongest predictor of feather growth, showing a strong quadratic relationship with $PC_{feather}$ (LMM, Gaussian distribution, 85% CI: −5.410 to −2.184) (Fig. 4 and Table 1). Noise had a positive impact on feather growth until ~70 dB(F), after which feather development was strongly reduced. Similarly, body size showed a quadratic relationship with noise, with decreases above ~70 dB(F) (LMM, Gaussian distribution, 85% CI: −2.589 to −0.499) (Fig. 4 and Table 1). These results also support the hypothesis that noise decreases fitness. However, the nonlinear effect of noise on both feather growth and body size was not predicted. This demonstrates that, either directly or indirectly, acoustic disturbance gradients can elicit complex responses.

High levels of noise exposure could distract parents and lead to increased vigilance and reduced provisioning efforts that result in body size reductions (7), a situation that might also partly explain the development of hypocorticism in nestlings. Additionally, the ability of the birds in our study, which are all insectivorous, to find prey could also be diminished at sites with elevated levels of noise (50, 79). Several consequences are linked to smaller nestlings, such as failure to return from migration (80), occupancy of low quality breeding habitat (81), and reduced reproductive success (82). Reduced feather development also likely decreases the ability to escape predators during fledgling stage (83).

At intermediate amplitudes nestlings exhibited accelerated growth of both feathers and body size. These moderate levels may increase pressure to develop faster and fledge earlier, while not incurring the costs of reduced provisioning in high noise exposure. As well, previous results in this system show that avian nest predators are sensitive to and avoid loud areas (2). It could be that, at intermediate amplitudes, breeding birds experience a noise mediated predator shield (84), in which predators are excluded but the consequences of noise on communication, cue detection, and distraction are minor or not perceived by individuals. This scenario would further facilitate provisioning and should be tested with experimental introductions of multimodal predator stimuli placed within medium amplitude zones. If the absence of predators in areas where noise has not yet degraded perception creates conditions in which parental care is enabled, we would expect to see negative effects of the proposed predator treatment on nestling development.

At lower amplitudes, nestlings had feather growth and body size more comparable to those in individuals from the loudest locations, perhaps reflecting perceived (and real) presence of predators or increased detectability of con and heterospecific acoustic signals about predators. It is worth noting that adult females and nestlings experience higher baseline cort in quiet areas, although it is unlikely that habitats with more natural acoustic conditions are poorer quality environments for breeding. Thus, given these documented physiological changes (e.g., hypocorticism and body condition), further experiments addressing longer term impacts of noise on survivorship of fledglings are needed.

We argue that the nonlinear effects of noise on development are best explained using the same mechanism that may cause chronic stress and hypocorticism: masking of acoustic cues that impairs risk perception and can lead to decreased provisioning effort. In other words, noise exposure creates sensory conditions

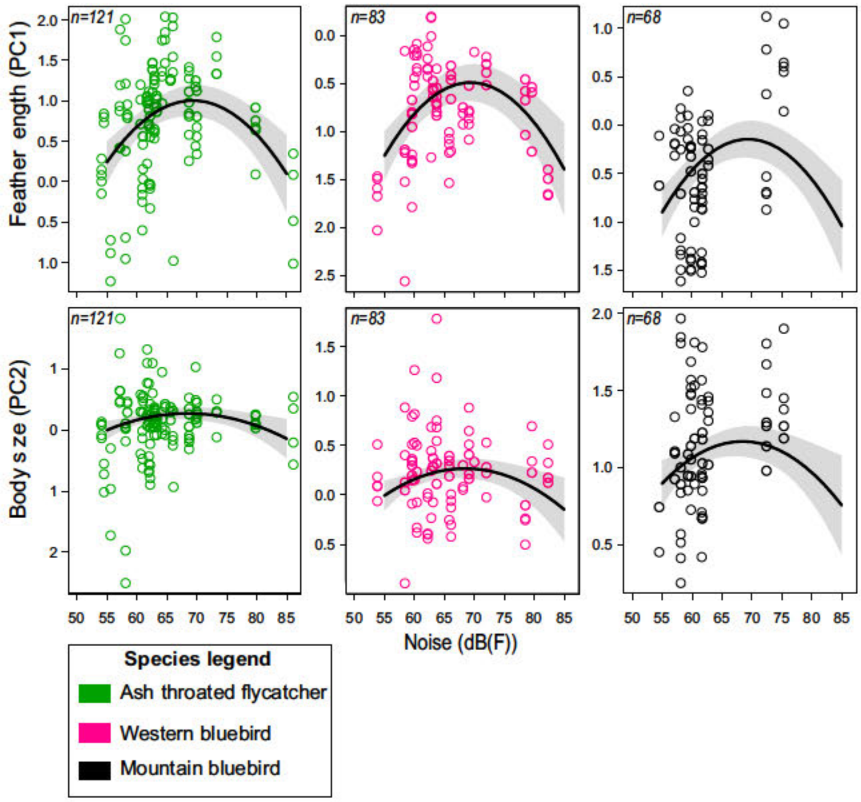

Fig. 4. The relationship between noise exposure and nestling development, represented by principal components axes, in all three species. Noise exposure had a nonlinear effect on feather development (*Upper Row*) and body size (*Lower Row*) in nestlings that was supported across species. The gray shaded areas indicate the 85% confidence intervals for each estimated effect.

analogous to actual high predation risk, leading to increased vigilance or distraction but with no mechanism for escape.

Effect of Cort on Fitness. Surprisingly, there was no relationship between nestling baseline or acute stressor induced cort on ei ther nestling body condition PC axis. Instead, maternal baseline cort levels had strong influences on body condition, but with stage and species specific variation. For example, during provisioning, the relationship between adult female baseline cort and nestling body condition is species specific. Maternal baseline cort had a negative effect on nestling $PC_{feather}$ in ash throated flycatchers (LMM, Gaussian distribution, $\beta_{cort} = -0.257$, 85% CI: -0.363 to -0.150) (Table 2) and a positive effect in western bluebirds (LMM, Gaussian distribution, $\beta_{cort} = 0.900$, 85% CI: 0.673 1.124; Table 2). Adult female baseline cort levels were nega tively associated with nestling PC_{size} in provisioning western bluebirds (LMM, Gaussian distribution, $\beta_{cort} = -0.183$, 85% CI: -0.343 to -0.025) (Table 2) and were positively associated in mountain bluebirds (LMM, Gaussian distribution, $\beta_{cort} = 0.383$, 85% CI: 0.162 0.608) (Table 2). These results suggest that direct relationships between cort and fitness depend on the context of life history and species.

In contrast to provisioning, during incubation, maternal baseline cort had a positive effect on hatching success (GLMM, binomial distribution, $\beta_{cort} = 0.323$, 85% CI: 0.059 0.668) (Fig. 5 and Table 2) that was supported across species. The finding that lower baseline cort during incubation is linked to reduced hatching success is similar to results found in free living house sparrows (*Passer domesticus*) (85) and tree swallows (*Tachycineta bicolor*) (86) and offers further support for the idea that down regulation of cort can have negative reproductive effects. This suggests that lower baseline cort levels may be useful in a conservation context as an indicator of low quality habitat. See Tables S8 S11 for a more detailed account of the effect of cort on fitness.

Conclusion

We leveraged a natural experiment in a wildlands system posi tioned in a large scale spatial gradient of anthropogenic noise to uncover a consistent trend of hypocorticism and complex and, in some cases, nonlinear fitness responses to noise exposure in a community of birds. Our work provides a predictive framework for understanding how chronic noise affects wildlife that is con sistent with our landscape scale and multispecies results as well as findings from several laboratory experimental systems in ver tebrates (25, 32).

Chronic noise exposure masks critical acoustic cues (8, 26, 47, 50) and can increase environmental uncertainty that alters risk perception, potentially driving reductions to provisioning rates through a trade off between vigilance and parental care. If nestlings employ compensatory strategies to cope with demands of reduced investment, earlier fledging at smaller body size should lead to net reductions in survival and success as juveniles and adults (67 69). Surprisingly, however, we also find that medium ampli tudes of noise are associated with potentially positive fitness out comes among offspring, suggesting that the consequences of altered environmental risk perception via the introduction of sensory pol lutants can be complex.

The critical discovery is that there is a strong and consistent multispecies pattern of hypocorticism in response to increased noise amplitude that is linked to negative fitness consequences. This suggests an updated framework for how noise affects wildlife and strengthens the case for reassessment of conservation physi ology theoretical models. Although there is an historical bias to expect elevated basal GCs in response to exposure to chronic

Table 2. Effects of cort on fitness

Dependent variable	N	Fixed effects	Random effects	k	R^2	AIC_c	Null AIC_c	χ^2
Fitness predicted by maternal baseline cort								
Hatching success	120	Baseline cort*+ Species*	None	4	0.190	90.649	92.459	0.044
Nestling feather growth (PC1)	96	Baseline cort* Species* Cort: species* Chicks*+ Distance*+ Tree cover*+	Pair Year	12	0.969	77.126	200.930	<0.001
Nestling body size (PC2)	96	Baseline cort+ Species* Cort: species* Distance* Lay date*	Site	10	0.802	99.297	184.633	<0.001
Fitness predicted by nestling baseline cort								
Nestling feather growth (PC1)	162	Baseline cort+ Species*	Site Nest ID	6	0.883	189.782	224.463	<0.001
Nestling body size (PC2)	162	Species* Lay date*	Nest ID	6	0.720	202.290	228.856	<0.001
Fitness predicted by nestling acute stressor induced cort								
Nestling feather growth (PC1)	161	Acute cort+ Species*	Nest ID	6	0.885	182.780	217.760	<0.001
Nestling body size (PC2)	161	Acute cort+ Species*	Nest ID	6	0.705	183.643	212.253	<0.001

Models are top models or are the highest performing models within two AIC_c that included a variable for cort. This table follows the formatting described in the legend of Table 1. Acute cort, acute stressor induced cort; k, parameters estimated.
*Predictors that do not include zero in their 85% confidence limits; all continuous predictors are marked with the direction of their effect on the dependent variable.

stressors, a careful analysis of field and laboratory studies of diverse nonmammalian and mammalian species revealed that there is no consensus endocrine response to chronic stress (87). Our work raises a subtle but important point. There may be consistent responses, such as hypocorticism, within the context of chronic, inescapable noise exposure for avian breeding communities. However, the body of evidence suggests GC regulation is also context dependent, and rather than expecting simple generalities about GC response to hold broadly, it is more critical to document dysregulation, along with associated negative health consequences (88, 89). The next frontier in conservation physiology research may be understanding the physiological and behavioral consequences of chronic adverse experience and GC dysregulation in the context of the collective adaptive or maladaptive behavioral, immune (e.g., inflammatory), autonomic, and neuroendocrine mediator responses (i.e., those involved in growth, reproduction, and metabolism) (90, 91).

We conclude by noting that conditions at our sites are not unusually loud compared with anthropogenic noise found in many areas across the United States, or globally. In the contiguous United States, estimates of the land area exposed to even moderate amplitude increases of 10 A weighted decibels [dB(A)] above natural levels is ~485,268.16 km^2 (92), and highly restricted protected areas and critical habitat for species of concern are not immune (3). A 10 dB(A) increase above natural levels translates into a 90% decrease in listening area (1, 3) (i.e., the spatial extent of detection of acoustic signals or cues) clearly a drastically reduced perceptual world. In this era of unprecedented, large scale human driven environmental change, preservation or recovery of natural acoustic conditions should be a key aspect of conservation planning and is a critical step toward successful conservation of protected species.

Materials and Methods

Study System. We conducted fieldwork, following University of Colorado Boulder Institutional Animal Care and Use Committee guidelines (Protocol 1404.03), at a long term study site in the Bureau of Land Management's Rattlesnake Canyon Habitat Management Area (RCHMA) in NW New Mexico during late spring and early summers from 2011 to 2014. The piñon (*Pinus edulis*) juniper (*Juniperus osteosperma*) woodland and shrub grassland ecosystem of RCHMA is heavily affected by large scale development of oil and gas infrastructure. Although developed by industry, RCHMA is remote, and animals in this region have very little contact with humans outside of minimally trafficked dirt roads and exposure to industry workers on well pads. Throughout this system, we installed a network of 240 cedar latched roof nest boxes (53). Although nest boxes were designed to exclude common opportunistic nest predators such as Woodhouse's scrub jay (*Aphelocoma woodhouseii*) and the least chipmunk (*Tamias minimus*) that appear largely responsible for nest predation in this system (2, 6), instances of predation by generalists such as deer mice (*Peromyscus* spp.) and bull snakes (*Pituophis catenifer sayi*) were occasionally observed at nest boxes across all noise levels.

We utilized the gradient of noise at RCHMA by placing nest boxes throughout the study area in 12 pairs of control and treatment sites, with 10 boxes per site. All sites were fully operational with nearly identical industrial equipment and similar levels of human activity on treatment and control sites (*SI Materials and Methods*). The key distinction between treatment and control sites was the presence of large compressor engines, which constantly produced high amplitude, low frequency noise on treatment sites (Fig. 1). Each control site was located at least 500 but no more than 1,000 m from its treatment pair, assuring that it was close enough to the treatment site to control for localized factors related to land cover composition but was far enough away to not be significantly affected by the noise from the compressor. Each control site was at least 500 m from any other noise producing wells that were not involved in this study. Noise levels across all pairs of treatment and control sites differed significantly, while forest cover and vegetation did not (2, 53). We placed nest boxes in a circular pattern at ~75 m, 125 m, and 175 m from the center of the well pad on control sites and from the compressor on treatment sites (Fig. 1). By placing the boxes at uniform distances from site centers we control for the effect of disturbance created by industry workers servicing equipment.

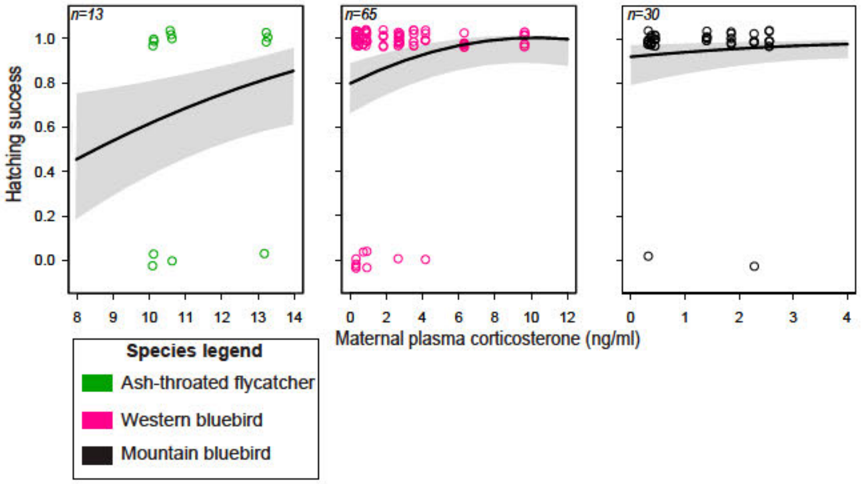

Fig. 5. Adult female baseline cort, measured during incubation, was positively associated with hatching success. The gray shaded areas indicate the 85% confidence intervals for each estimated effect.

Nest Monitoring. We began monitoring nest boxes in early May each year, coinciding with the start of breeding season. Following a system wide check for nesting activity, each box was monitored biweekly. Upon recording nesting activity in a box, we rated each nest as 25, 50, 75, or 100% complete to prioritize further monitoring efforts. We checked complete nests every other day until at least one egg had been laid. However, logistical constraints sometimes restricted searching efforts. When more than one egg was found in a nest, we followed standard methodology (93, 94) and used natural history information on egg laying intervals and incubation periods (57, 95, 96) to back calculate the initial lay date. Observations continued until the date when the first chick of each brood hatched, or "day zero." These data were used to schedule the nestling sampling date, which allowed the chicks to develop without unnecessary disturbance by our research team until day 12.

Capture Methods and Hormone Assays. Nestlings were in prefledging stage during sampling and were hand captured from the box. We were not able to differentiate between nestling sexes. Adults were hand captured with the use of a sliding door trap on the nest box initiated by a researcher hidden behind a bush and holding a line attached to the hole block. We focused our adult study on breeding females only, and we identified females through behavior and coloration and, after capture, using the presence or absence of a brood patch. Thus, we were able to take into full account the effects of parental sex and life stage, which, when not controlled, can obscure important signals due to innate differences in GC levels between these groups (97). Once the target adult female entered the box, the line was pulled, and the timer was started.

Blood was taken within 3 min after capture from each individual to measure baseline levels of stress hormone (98). Less than 100 μL of blood per individual was collected into heparinized hematocrit tubes from a puncture by a sterile needle in the brachial vein and was stored on ice until centri fugation. Birds were banded with standard issue metal bands from the US Geological Survey Bird Banding Laboratory (#22837). We also measured body mass, wing length, tail length, and tarsus length for a general gauge of overall condition after baseline samples had been collected. After 10 min of restraint in a cloth sack, we sampled individuals for acute stressor induced cort levels. We recognize that our protocol is shorter than typical stress series restraint protocols, and we present these data as indicators of HPA responsiveness and not the maximum amount of cort released in response to a stressor. However, 10 min of restraint is likely enough time to elicit max imum cort release in birds (99 101). Due to concerns about nest abandon ment, which reduced sampling feasibility in these species, we do not include acute stressor induced cort measurements from adults. Details on sample handling, accuracy, and variation, especially with regard to low concentra tions of cort, are available in *SI Materials and Methods*.

Measurement of Noise and Other Habitat Factors. We measured the equivalent continuous sound level [L_{eq}, dB(F), fast response, re. 20 μPa] for 1 min at every nest box using a Larson Davis System 824 sound pressure meter. See Kleist et al. (53) and Fig. S1 and *SI Materials and Methods* for more details on sound measurements. Tree cover was measured using ArcGIS and National Land Cover Dataset following methods described by Kleist et al. (53). We include tree cover because all three focal species prefer open, sparse shrublands rather than closed, forested habitats (57, 95, 96). Additionally, we include the distance to the center of the well pad to control for the effect of nest box's proximity to the well pad, which, irrespective of noise, may include low levels of chemical pollution and the infrequent presence of humans.

Temporal and Life History Factors. Baseline and acute stressor induced levels of cort can relate to seasonality, life stages, and brood size, and we gathered data to control for these effects (21). We included sampling time as a fixed effect because GC levels are known to fluctuate throughout the day (25, 102). We included lay date in models since this variable corresponds with peaks in food availability and likely affects cort, relative to individual arrival times. Recent work suggests that cort levels are context dependent (27, 66, 103) and that, within the breeding attempt, brooding and provisioning might require different amounts of cort; i.e., increased cort can facilitate provisioning (104). To control for these differences, we differentiate be tween blood drawn from brooding or provisioning adult females. Addi tionally, nest investment and reproductive potential can influence cort levels (103), and although we are not able to test directly for an effect of maternal age on nestling response, we do include a nest ID variable to control for individual effects. Finally, the brood size in each nest was recorded to con trol for the increased challenge of rearing large broods, which has been shown to affect incubation and lead to decreases in nest success (105).

Accounting for Potential Self Sorting. In the event that lower quality birds are relegated to or inadvertently select habitats with more noise exposure, the results of an analysis seeking to determine the effect of noise per se would potentially be biased. We tested whether this was a possibility by measuring body mass of all adult females, which is a reliable indicator of condition (106), before performing further analyses. We created linear models with noise and female body weight to determine if any correlation existed between noise levels at the nest box [dB(F)] and female condition. Across RCHMA, we found no evidence that heavier, higher quality adult females were preferentially selecting quieter locations for nesting (Table S1), and therefore any variation in fitness and stress hormones is likely a result of habitat factors present at the nest site.

Model Testing Framework. We used LMM and GLMM models with the lme4 package in the R statistical language, including a fixed term for "species," to test for effects of noise on cort and several measures of fitness, including hatching success and nestling body condition. We also tested for any re lationship between cort and fitness (27). When species was significant as a fixed effect, we examined species specific models.

The first model set examined the effects of noise on both nestling and adult female cort levels and included continuous fixed effects for noise, species, tree cover, distance to well pad, lay date, time of day, brood size and, in adults, a categorical effect for life stage, included as either incubation or provisioning. We tested baseline cort in adults and both baseline and acute stressor induced cort, measured 10 min after capture, in nestlings.

The second model, which is the first of two models focused on uncovering the effect of noise on fitness, explored the relationship between noise and egg hatching success. We defined hatching success as a binomial response in which each egg that was laid in a nest was included; those that hatched were marked as a 1, and those that did not hatch were marked as 0 (107). The

binomial response term for hatching was included in models with noise, species, lay date, distance to well pad, tree cover, and clutch size.

In addition to measuring the effect of noise and other factors on hatching success, a direct measure of reproductive success, we created a third modeling set that included nestling condition as a response term. Nestling developmental changes can be a subtler but equally important indicator of fitness (52, 77). We used principal components analysis (PCA) with varimax rotation (principal function in the psych library for R) to load measurements of nestling wing chord (in millimeters), rectrices (in millimeters), tarsus length (in millimeters), and mass (in grams) onto appropriate axes. These measurements were all taken on the 12th day after hatching, because that is the final day where nest visitation is unlikely to instigate disturbance induced prefledging (North American Bluebird Society, www.nabluebirdsociety.org). These morphological measures loaded on two axes with PC1 explaining 47% and PC2 37% of the variation in the data (Table S2). Wing chord length and length of rectrices loaded strongly onto PC1, while mass and tarsus length loaded strongly onto PC2; because of these loadings, we named these axes "$PC_{feather}$" and "PC_{size}," respectively. We placed these axes as response terms in models that include fixed effects for noise, species, tree cover, distance to well pad, lay date, and brood size. Because nestling mass is known to fluctuate throughout the day, we also included a term for time of day in model selection for PC_{size}. After initial exploration of data distributions, we included both $PC_{feather}$ and PC_{size} as second order polynomials, suggesting that developmental effects of noise might vary nonlinearly with amplitude. In experimental research with humans, vigilance is known to peak at medium amplitudes of noise (108). This has important implications, via noise mediated foraging vigilance trade offs (7), and could translate to reduced provisioning rates and altered development in nestlings, in a similar nonlinear fashion.

Finally, we explored the relationship between cort and fitness. In three separate models, we incorporated nestling body condition as a response to nestling baseline cort, nestling acute stressor induced cort, and maternal baseline cort measured during provisioning. We also analyzed the effect of maternal baseline cort measured during incubation on hatching success. For all cort fitness models we included an interaction between cort and species, as cort levels are known to vary systematically across species. Although the focus of this paper is to explore the effect of acoustic habitat disturbance on physiology and fitness, and not the effect of maternal cort on nestling growth, we included these models to more fully examine if changes to baseline cort resulting from noise exposure are linked to negative fitness consequences. We did not use noise as a predictor in these models to better isolate effects of maternal cort on fitness relevant measures.

For all models, we included random effects terms to control for variation in data attributable to environmental factors associated with pair, site, and nest box (Fig. 1) and also included a random effect for year. Nestling cort and fitness models included a random effect for Nest ID to control for brood identity in nestlings and for multiple breeding attempts in adults.

Model selection was conducted using an information criterion approach to compare AIC_c scores between models. All continuous fixed effects were transformed to z scores using the scale function in R, which allows direct comparison of effects and improves model fit. After initially fitting the full model, random effects that explained near zero variance (variance ≤ 0.0001) were removed to improve the fit of the model (109). Additionally, we refit models as GLMM if all random effects were removed during model selection. We considered models with all combinations of hypothesized predictor variables and designated all models within two ΔAIC_c and that differed from the null model with identical random effects as determined by a likelihood ratio test as strongly supported. We calculated effect sizes and 85% CIs for individual predictors from supported models (7, 110). For full results, including effects of other predictors and model selection, see Tables S3 S7. All data and the R code used to produce this work will be made available online in a Dryad digital data repository.

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From:	Fox, Joanna
To:	Burkart, Greta; Janet Jorgenson; Christopher Latty; Roy Churchwell; Stephen Arthur; Jennifer Reed; Roger Kaye; Hollis Twitchell
Cc:	Steve Berendzen
Subject:	Fwd: Arctic Refuge 1002 Coastal Plain: NPRA FEIS and Table of Stipulations used in developing NPRA leasing plan
Date:	Wednesday, February 21, 2018 5:25:27 PM
Attachments:	Table 2.3 Stips ROPS BMS Vol1 NPR-A Final IAP FEIS.pdf

Steve and I would like to get together with all of you to talk a little more about what might be expected of us as cooperators in the development of BLM's EIS for oil and gas exploration and leasing in the 1002 area. Will you please join us in the Refuges conference room at 10 am tomorrow morning (Thursday)? For those of you who can only join by phone, the call-in information follows:

[redacted]
Passcode: [redacted]

Thank you!

____

Joanna L. Fox
Deputy Refuge Manager
Arctic National Wildlife Refuge
101 12th Avenue, Room 236
Fairbanks, AK 99701
(907) 456-0549

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www.facebook.com/arcticnationalwildliferefuge

"Do what you can, with what you have, where you are." -- Theodore Roosevelt

---------- Forwarded message ----------
From: **Wendy Loya** <wendy_loya@fws.gov>
Date: Tue, Feb 20, 2018 at 4:53 PM
Subject: Arctic Refuge 1002 Coastal Plain: NPRA FEIS and Table of Stipulations used in developing NPRA leasing plan
To: Charles Hamilton <charles_hamilton@fws.gov>, Greta Burkart <greta_burkart@fws.gov>, Janet Jorgenson <janet_jorgenson@fws.gov>, Paul Leonard <paul_leonard@fws.gov>, Edward Decleva <edward_decleva@fws.gov>, Peter Butteri <peter_butteri@fws.gov>, Randy Brown <randy_j_brown@fws.gov>, Christopher Latty <christopher_latty@fws.gov>, Roy Churchwell <roy_churchwell@fws.gov>, Richard Lanctot <richard_lanctot@fws.gov>, Jim Johnson <jim_a_johnson@fws.gov>, Steve Lewis <steve_b_lewis@fws.gov>, Michael Swaim <michael_swaim@fws.gov>, Julian Fischer <julian_fischer@fws.gov>, Ted Swem <ted_swem@fws.gov>, Ryan Wilson <ryan_r_wilson@fws.gov>, Stephen Arthur <stephen_arthur@fws.gov>, Hollis Twitchell <hollis_twitchell@fws.gov>, Susan LaKomski <susan_lakomski@fws.gov>, Jennifer Reed <jennifer_reed@fws.gov>, Angela Matz <angela_matz@fws.gov>, Roger Kaye <roger_kaye@fws.gov>, Eva Patton <eva_patton@fws.gov>, Robbin Lavine <robbin_lavine@fws.gov>
Cc: Eric Taylor <eric_taylor@fws.gov>, John Trawicki <john_trawicki@fws.gov>, Drew Crane <drew_crane@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, Joanna Fox

<joanna_fox@fws.gov>, Stephanie Brady <stephanie_brady@fws.gov>, Tracy Fischbach <tracy_fischbach@fws.gov>, Doug Damberg <doug_damberg@fws.gov>, Carl Johnson <carl_johnson@fws.gov>, Socheata Lor <socheata_lor@fws.gov>

Dear FWS colleagues,

As Greg Siekaniec announced at the February All Staff meeting, I am serving as the Regional Point of Contact (POC) for the 1002 Coastal Plain of the Arctic National Wildlife Refuge Program to establish and oil and gas program. I work with POCs from the Arctic Refuge (Steve Berendzen and Joanna Fox), NWRs program (John Trawicki), FES (Drew Crane) and Migratory Birds (Eric Taylor) and other FWS staff to gather and share information with the Regional Director, BLM, USGS and other agencies. FWS staff can go to their POC for more information on the status of the process or with any questions.

At this time, it appears BLM-Alaska will lead preparation of an EIS to establish a leasing plan for the 1002 Coastal Plain of the Arctic National Wildlife Refuge, and the FWS Alaska Region is expecting to be a cooperating agency and provide information on the natural resources and other areas where we have expertise, to inform the plan. The goal communicated with BLM from DC is a lease sale within 2 years. I would like to provide some additional information to help you understand how FWS could contribute to the EIS, although there is still uncertainty until BLM is told to publish a Notice of Intent to prepare an EIS and we are established as a partner in its development.

The primary way which BLM manages activities during exploration and development is through stipulations (Stips) and required operating procedures (ROPs) or best management practices(BMPs). I'd like to help you become familiar with these as they may answer questions you have already about how we will protect the lands, waters and wildlife of the Refuge while making the lands available for leasing and development. They will also help you start thinking about how you will be asked to use your knowledge to inform a Leasing Plan for the 1002 Coastal Plain in the Arctic National Wildlife Refuge in the coming months, as we will want to identify where on the coastal plain different Stips and ROPs should be applied.

Attached is a PDF that contains the 'Alternative stipulations and required operating procedures/best management practices' presented in the NPRA Integrated Activity Plan (IAP)/Final EIS, which is the title of the plan approved by BLM in 2013 for management of the entire NPRA. BLM evaluated 4 Alternatives in the Draft EIS (A,B,C,D), and added a 5th alternative in the Record of Decision (ROD; B-2). It gets complicated to understand all of the alternatives, but the Preferred Alternative B-2 which they selected and are currently using to manage the NPRA generally provided a balance between making lands available for leasing and making high value habitats unavailable for leasing or leased but with protective measures.

Because the legislation states that the 1002 Coastal Plain shall be managed in a manner similar to NPRA, it is possible that the EIS for the Refuge will include Alternatives that involve unique combinations of these Stips.

Of particular interest will be on original page 84, which is the start of the ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS ("K" Stips/BMPs). These are the primary tools for protecting sensitive and high value habitats/resources.

I have contacted the BLM Arctic District Field Office Acting Manager Shelly Jones to discuss how we can bring FWS and BLM staff together to discuss these Stips/ROPS/BMPs and what might be different for the Arctic Refuge. I will share more information when we have a plan, and welcome your feedback on what might make that most useful as well as what other information/training needs you might have to help us work with BLM on an EIS.

If you want to view or download the full NPRA IAP/FEIS, you can do so here: https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage&currentPageId=14702

BLM has a handy NEPA handbook that can help you understand the process, and identify where you'll have the opportunity to contribute to writing and/or review: https://www.ntc.blm.gov/krc/uploads/366/NEPAHandbook_H-1790_508.pdf

Again, this is all tentative until we receive further direction from BLM.

Thank you,

Wendy

Dr. Wendy M. Loya,

Arctic Program Coordinator, Office of Science Applications

US Fish and Wildlife Service

Anchorage, Alaska

907.786.3532 (office)

907.227.2942 (mobile)

Table 2-3. Alternative stipulations and required operating procedures/best management practices[2]

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-1 Required Operating Procedure **Northeast** Objective: Protect the health and safety of oil field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, State, and local law and regulations. Requirement/Standard: Areas of operation shall be left clean of all debris. **Northwest** Objective: Protect the health and safety of oil field workers and the general public by avoiding the disposal of solid waste and garbage near areas of human activity. Requirement/Standard: Same.	***A-1 Best Management Practice*** Objective: Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, State, and local law and regulations. Requirement/Standard: Areas of operation shall be left clean of all debris.			
A-2 Required Operating Procedure **Northeast** Objective: Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations. Requirement/Standard: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. The plan shall be submitted to the authorized officer for approval, in consultation with federal, State, and North Slope Borough regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application.	***A-2 Best Management Practice*** Objective: Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil and gas field workers and the general public. Avoid human-caused changes in predator populations. Requirement/Standard: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. The plan shall be submitted to the authorized officer for approval, in consultation with federal, State, and North Slope Borough regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application.			

[2] All setback distances in included in this table are to be measured as of the time of the application for a permit for a development. In addition, for Alternatives B-1, B-2, C, and D, facility development along the coast would be required to be designed to maintain the prescribed setback distance for the anticipated life of the facility.

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>Management decisions affecting waste generation shall be addressed in the following order of priority: (1) prevention and reduction, (2) recycling, (3) treatment, and (4) disposal. The plan shall consider and take into account the following requirements:
a. Methods to avoid attracting wildlife to food and garbage. All feasible precautions shall be taken to avoid attracting wildlife to food and garbage. (A list of approved precautions, specific to the type of permitted use, can be obtained from the authorized officer.)
b. Disposal of putrescible waste. Requirements prohibit the burial of garbage. Lessees and permitted users shall have a written procedure to ensure that the handling and disposal of putrescible waste will be accomplished in a manner that prevents the attraction of wildlife. All putrescible waste shall be incinerated, backhauled, or composted in a manner approved by the authorized officer. All solid waste, including incinerator ash, shall be disposed of in an approved waste-disposal facility in accordance with EPA and Alaska Department of Environmental Conservation regulations and procedures. The burial of human waste is prohibited except as authorized by the authorized officer.
c. Disposal of pumpable waste products. Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection in accordance with EPA, Alaska Department of Environmental Conservation, and the Alaska Oil and Gas Conservation Commission regulations and procedures. On-pad temporary muds and cuttings storage, as approved by Alaska Department of Environmental Conservation, will be allowed as necessary to facilitate annular injection and/or backhaul operations.
d. Disposal of wastewater and domestic wastewater. The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by a National Pollutant Discharge Elimination System or State permit.

Northwest
<u>Objective</u>: Same
<u>Requirement/Standard</u>: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. Management decisions affecting waste generation shall be addressed in the following order of priority: (1) prevention and</td><td colspan="4">Management decisions affecting waste generation shall be addressed in the following order of priority: (1) prevention and reduction, (2) recycling, (3) treatment, and (4) disposal. The plan shall consider and take into account the following requirements:
a. Methods to avoid attracting wildlife to food and garbage. The plan shall identify precautions that are to be taken to avoid attracting wildlife to food and garbage.
b. Disposal of putrescible waste. Requirements prohibit the burial of garbage. Lessees and permitted users shall have a written procedure to ensure that the handling and disposal of putrescible waste will be accomplished in a manner that prevents the attraction of wildlife. All putrescible waste shall be incinerated, backhauled, or composted in a manner approved by the authorized officer. All solid waste, including incinerator ash, shall be disposed of in an approved waste-disposal facility in accordance with EPA and Alaska Department of Environmental Conservation regulations and procedures. The burial of human waste is prohibited except as authorized by the authorized officer.
c. Disposal of pumpable waste products. Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection in accordance with EPA, Alaska Department of Environmental Conservation, and the Alaska Oil and Gas Conservation Commission regulations and procedures. On-pad temporary muds and cuttings storage, as approved by Alaska Department of Environmental Conservation, will be allowed as necessary to facilitate annular injection and/or backhaul operations.
d. Disposal of wastewater and domestic wastewater. The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by a National Pollutant Discharge Elimination System or State permit.</td></tr>
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WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>reduction, (2) recycling, (3) treatment, and (4) disposal. The plan shall be submitted to the authorized officer for approval, in consultation with federal, State, and North Slope Borough regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application. The plan shall consider and take into account the following requirements: [Requirements a through d are the same as in Northeast.]</td><td colspan="4"></td></tr>
<tr><td>A-3 Required Operating Procedure
Northeast
<u>Objective</u>: Minimize pollution through effective hazardous-materials contingency planning.

<u>Requirement/Standard</u>: For oil- and gas-related activities, a hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures applicable to fuel and hazardous substances handling (associated with transportation vehicles) shall consist of best management practices if approved by the authorized officer. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials, or companies), and names and phone numbers of federal, State, and North Slope Borough contacts. Other federal and State regulations may apply and require additional planning requirements. All appropriate staff shall be instructed regarding these procedures.
In addition contingency plans related to facilities developed for oil production shall include requirements to:
a. Provide refresher spill-response training to North Slope Borough and local community spill-response teams on a yearly basis.
b. Plan and conduct a major spill-response field-deployment drill annually.
c. Prior to production and as required by law, develop spill prevention and response contingency plans and participate in development and maintenance of the North Slope Subarea Contingency Plan for Oil and Hazardous Substances Discharges/Releases for the National Petroleum Reserve-Alaska operating area. Planning shall include development</td><td colspan="4">A-3 Best Management Practice

<u>Objective:</u> Minimize pollution through effective hazardous-materials contingency planning.

<u>Requirement/Standard:</u> For oil- and gas-related activities, a hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures in the plan applicable to fuel and hazardous substances handling (associated with transportation vehicles) shall consist of best management practices if approved by the authorized officer. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials or companies), and names and phone numbers of federal, State, and North Slope Borough contacts. Other federal and State regulations may apply and require additional planning requirements. All appropriate staff shall be instructed regarding these procedures.

In addition contingency plans related to facilities developed for oil production shall include requirements to:
a. Provide refresher spill-response training to North Slope Borough and local community spill-response teams on a yearly basis.
b. Plan and conduct a major spill-response field-deployment drill annually.
c. Prior to production and as required by law, develop spill prevention and response contingency plans and participate in development and maintenance of the North Slope Subarea Contingency Plan for Oil and Hazardous Substances Discharges/Releases for the National Petroleum Reserve-Alaska operating area. Planning shall include development and funding of detailed (e.g., 1:26,000 scale) environmental sensitivity index maps for the lessee's/permittee's operating area and areas outside the lessee's/permittee's operating area that could be affected by their activities. (The specific area to be</td></tr>
</table>

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>and funding of detailed (e.g., 1:26,000 scale) environmental sensitivity index maps for the lessee’s operating area and areas outside the lessee’s operating area that could be affected by their activities. (The specific area to be mapped shall be defined in the lease agreement and approved by the authorized officer in consultation with appropriate resource agencies.) Maps shall be completed in paper copy and geographic information system format in conformance with the latest version of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration’s Environmental Sensitivity Index Guidelines. Draft and final products shall be peer reviewed and approved by the authorized officer in consultation with appropriate federal, State, and North Slope Borough resource and regulatory agencies.

Northwest
<u>Objective</u>: Same
<u>Requirement/Standard</u>: For oil- and gas-related activities, a hazardous-materials emergency-contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures applicable to fuel and hazardous substances handling (associated with transportation vehicles) may consist of best management practices if approved by the authorized officer. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials or companies), and names and phone numbers of federal, State, and North Slope Borough contacts. Other federal and State regulations may apply and require additional planning requirements. All staff shall be instructed regarding these procedures.</td><td colspan="4">mapped shall be defined in the lease agreement and approved by the authorized officer in consultation with appropriate resource agencies.) Maps shall be completed in paper copy and geographic information system format in conformance with the latest version of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration’s Environmental Sensitivity Index Guidelines. Draft and final products shall be peer reviewed and approved by the authorized officer in consultation with appropriate federal, State, and North Slope Borough resource and regulatory agencies.</td></tr>
</table>

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-4 Required Operating Procedure **Northeast** Objective: Minimize the impact of contaminants on fish, wildlife, and the environment; including wetlands, marshes and marine waters; as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety. Requirement/Standard: Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR § 112 (Oil Pollution Act). The plan shall consider and take into account the following requirements: a. On-site Clean-up Materials. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment. b. Storage Containers. Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the authorized officer that in total exceed 1,320 gallons shall be stored within an impermeable lined and diked area or within approved alternate storage containers, such as over packs, capable of containing 110% of the stored volume. In areas within 500 feet of waterbodies, fuel containers are to be stored within appropriate containment. c. Liner Materials. Liner material shall be compatible with the stored product and capable of remaining impermeable during typical weather extremes expected throughout the storage period. d. Permanent Fueling Stations. Permanent fueling stations shall be lined or have impermeable protection to prevent fuel migration to the environment from overfills and spills. e. Proper Identification of Containers. All fuel containers, including barrels and propane tanks, shall be marked with the responsible party's name, product type, and year filled or purchased.	***A-4 Best Management Practice*** Objective: Minimize the impact of contaminants on fish, wildlife, and the environment; including wetlands, marshes and marine waters; as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety. Requirement/Standard: Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR § 112 (Oil Pollution Act). The plan shall consider and take into account the following requirements: a. On-site Clean-up Materials. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment. b. Storage Containers. Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the authorized officer that in total exceed 1,320 gallons shall be stored within an impermeable lined and diked area or within approved alternate storage containers, such as over packs, capable of containing 110% of the stored volume. In areas within 500 feet of waterbodies, fuel containers are to be stored within appropriate containment. c. Liner Materials. Liner material shall be compatible with the stored product and capable of remaining impermeable during typical weather extremes expected throughout the storage period. d. Permanent Fueling Stations. Permanent fueling stations shall be lined or have impermeable protection to prevent fuel migration to the environment from overfills and spills. e. Proper Identification of Containers. All fuel containers, including barrels and propane tanks, shall be marked with the responsible party's name, product type, and year filled or purchased.			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>f. <u>Notice of Reportable Spills</u>. Notice of any reportable spill (as required by 40 CFR § 300.125 and 18 AAC § 75.300) shall be given to the authorized officer as soon as possible, but no later than 24 hours after occurrence.
g. <u>Identification of Oil Pans (“duck ponds”)</u>. All oil pans shall be marked with the responsible party’s name.

Northwest
<u>Objective</u>: Minimize the impact of contaminants on fish, wildlife, and the environment; including wetlands, marshes and marine waters; as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and activities. Protect public health and safety.
<u>Requirement/Standard:</u> Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR 112 (OPA). The plan shall consider and take into account the following requirements:
a. <u>On-site clean-up materials</u>. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.
b. <u>Storage Containers</u>. Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the authorized officer in excess of 1,320 gallons in storage capacity, shall be stored within an impermeable lined and diked area or within approved alternate storage containers such as overpacks, capable of containing 110% of the stored volume.

[Requirements c through f are the same as in Northeast.]</td><td colspan="4">f. <u>Notice of Reportable Spills</u>. Notice of any reportable spill (as required by 40 CFR § 300.125 and 18 AAC § 75.300) shall be given to the authorized officer as soon as possible, but no later than 24 hours after occurrence.

g. <u>Identification of Oil Pans (“duck ponds”)</u>. All oil pans shall be marked with the responsible party’s name.

(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
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WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-5 Required Operating Procedure **Northeast** <u>Objective</u>: Minimize the impact of contaminants from refueling operations on fish, wildlife and the environment. <u>Requirement/Standard</u>: Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any water body with the exception of small caches (up to 210 gallons) for motor boats, float planes, ski planes, and small equipment, e.g., portable generators and water pumps, will be permitted. The authorized officer may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions. **Northwest** <u>Objective</u>: Minimize the impact of contaminants from refueling operations on fish, wildlife and the environment. <u>Requirement/Standard</u>***:*** Refueling of equipment within 500 feet of the active floodplain of any fish-bearing water body and 100 feet of non-fish-bearing waterbodies is prohibited. Small caches (up to 210 gallons) for motorboats, float planes, ski planes**,** and small equipment, e.g., portable generators and water pumps, will be permitted. The authorized officer may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions.	***A-5 Best Management Practice*** <u>Objective</u>: Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment. <u>Requirement/Standard</u>: Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any water body with the exception of small caches (up to 210 gallons) for motor boats, float planes, ski planes, and small equipment, e.g., portable generators and water pumps, will be permitted. The authorized officer may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			
A-6 Required Operating Procedure **Northeast** <u>Objective</u>: Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process. <u>Requirement/Standard</u>: Surface discharge of reserve-pit fluids is prohibited. **Northwest** <u>Objective</u>: Same. <u>Requirement/Standard</u>: Surface discharge of reserve-pit fluids is prohibited unless authorized by applicable National Pollutant Discharge Elimination System, Alaska Department of Environmental Conservation, and North Slope Borough permits (as appropriate) and approved by the authorized officer.	***A-6 Best Management Practice*** <u>Objective</u>: Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process. <u>Requirement/Standard</u>: Surface discharge of reserve-pit fluids is prohibited. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>A-7 Required Operating Procedure
Northeast
<u>Objective</u>: Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.
<u>Requirement/Standard</u>: Discharge of produced water in upland areas and marine waters is prohibited.
Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Procedures for the disposal of produced fluids shall meet the following:
a. In upland areas, including wetlands, disposal will be by subsurface-disposal techniques. The authorized officer may permit alternate disposal methods if the lessee demonstrates that subsurface disposal is not feasible or prudent and the alternative method will not result in adverse environmental effects.
b. In marine waters, approval of discharges by the authorized officer will be based on a case-by-case review of environmental factors and consistency with the conditions of a National Pollutant Discharge Elimination System permit. Discharge of produced fluids will be prohibited at locations where currents and water depths, in combination with other conditions, are not adequate to prevent impacts to known biologically sensitive areas. Alternate disposal methods will require an National Pollutant Discharge Elimination System permit certified by the State.</td><td colspan="4">A-7 Best Management Practice

<u>Objective</u>: Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.

<u>Requirement/Standard</u>: Discharge of produced water in upland areas and marine waters is prohibited.

(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
<tr><td>A-8 Required Operating Procedure
Northeast
<u>Objective</u>: Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.
<u>Requirement/Standard</u>: Oil and gas lessees and their contractors and subcontractors will, as a part of preparation of lease operation planning, prepare and implement bear-interaction plans to minimize conflicts between bears and humans. These plans shall include measures to:

a. Minimize attraction of bears to the drill sites.
b. Organize layout of buildings and work areas to minimize human/bear interactions.
c. Warn personnel of bears near or on drill sites and identify proper procedures to be followed.</td><td colspan="4">A-8 Best Management Practice

<u>Objective</u>: Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.
<u>Requirement/Standard</u>: Oil and gas lessees and their contractors and subcontractors will, as a part of preparation of lease operation planning, prepare and implement bear-interaction plans to minimize conflicts between bears and humans. These plans shall include measures to:

a. Minimize attraction of bears to the work sites.
b. Organize layout of buildings and work sites to minimize human/bear interactions.

c. Warn personnel of bears near or on work sites and identify proper procedures to be followed.</td></tr>
</table>

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>d. Establish procedures, if authorized, to discourage bears from approaching the drill site.
e. Provide contingencies in the event bears do not leave the site or cannot be discouraged by authorized personnel.
f. Discuss proper storage and disposal of materials that may be toxic to bears.
g. Provide a systematic record of bears on the site and in the immediate area.
h. Encourage lessee/permittee to participate and comply with the Incidental Take Program under the Marine Mammal Protection Act.[3]

Northwest
<u>Objective</u>: Minimize conflicts resulting from interaction between humans and bears during leasing and associated activities.

<u>Requirement/Standard</u>: Same, except lacks subpart h.</td><td colspan="4">d. Establish procedures, if authorized, to discourage bears from approaching the work site.
e. Provide contingencies in the event bears do not leave the work site or cannot be discouraged by authorized personnel.
f. Discuss proper storage and disposal of materials that may be toxic to bears.

g. Provide a systematic record of bears on the work site and in the immediate area.</td></tr>
<tr><td>A-9 Required Operating Procedure
Northeast
<u>Objective</u>: Reduce air quality impacts.
<u>Requirement/Standard</u>: Concurrent with implementation of the requirement for adoption of use of ultra low sulfur diesel in the “North Slope Ultra Low Sulfur Diesel Transition Agreement,” as amended, between the State of Alaska, BP Exploration (Alaska) Inc. and ConocoPhillips Alaska, Inc., or implementation of federal regulations requiring use of “ultra low sulfur” diesel within NPR-A if these regulations take effect prior to the transition agreement, all oil and gas operations (vehicles and equipment) that burn diesel fuels must use “ultra low sulfur” diesel as defined by the Alaska Department of Environmental Conservation-Division of Air Quality, subject to its availability. The use of alternative diesel fuel may be considered and approved by BLM’s authorized officer on a case-by-case basis.

Northwest
No comparable provision.</td><td colspan="4">A-9 Best Management Practice

<u>Objective</u>: Reduce air quality impacts.
<u>Requirement/Standard</u>: All oil and gas operations (vehicles and equipment) that burn diesel fuels must use “ultra-low sulfur” diesel as defined by the Alaska Department of Environmental Conservation-Division of Air Quality.</td></tr>
</table>

[3] An analogous subparagraph A-8h is not included in Alternatives B through D. The polar bear is now provided protection under both the MMPA and the ESA.

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-10 Required Operating Procedure **Northeast** <u>Objective</u>: Prevent unnecessary or undue degradation of the lands and protect health. <u>Requirement/Standard</u>: This measure includes the following elements: a. Prior to initiation of a NEPA analysis for an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the lessee shall obtain on-site background air quality and meteorology data to be used in predicting potential future air quality conditions resulting from the proposed action and other reasonably foreseeable future actions. Monitoring should examine the background concentration of criteria air pollutants. Monitoring data collection must meet BLM standards for quality control and quality assurance before use. (The BLM may consult with the applicant and appropriate federal, State, and/or local agencies to avoid duplication of effort.) The monitoring mechanism for the predevelopment stage would be one that does not require an on-site air polluting emission source. If background data exists that the authorized officer determines is representative of that existing at the proposed development site, the authorized officer may waive this requirement. b. For developments with a potential for air pollutant emissions as described in subparagraph (a), the lessee shall prepare (and submit for BLM approval) a complete list of reasonably foreseeable air pollutant emissions, including, but not limited to criteria air pollutants and hazardous air pollutants designated under authority of the Clean Air Act, as amended. c. For developments with a potential for air pollutant emissions as described in subparagraph (a) and informed by the pollutant emissions identified in subparagraph (b), the authorized officer may require air quality modeling using BLM-approved atmospheric dispersion models that are appropriate for local conditions. (The authorized officer may consult with the applicant and appropriate federal, State, and/or local agencies regarding modeling to inform his/her decision and avoid duplication of effort.) The modeling shall compare predicted impacts to all applicable local, State, and federal air quality standards and increments, as well as other scientifically defensible significance thresholds (such as impacts to air quality related values, incremental cancer risks, etc.).	***A-10 Best Management Practice*** <u>Objective</u>: Prevent unnecessary or undue degradation of the lands and protect health. <u>Requirement/Standard</u>: This measure includes the following elements: a. Prior to initiation of a NEPA analysis for an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source (hereafter project), the authorizing officer (BLM) may require the project proponent to provide a minimum of one year of baseline ambient air monitoring data for any pollutant(s) of concern as determined by BLM if no representative air monitoring data are available for the project area, or existing representative ambient air monitoring data are insufficient, incomplete, or do not meet minimum air monitoring standards set by the Alaska DEC or the EPA. If BLM determines that baseline monitoring is required, this pre-analysis data must meet Alaska DEC and EPA air monitoring standards, and cover the year immediately prior to the submittal. Pre-project monitoring may not be appropriate where the life of the project is less than one year. b. The BLM may require monitoring for the life of the project depending on the magnitude of potential air emissions from the project, proximity to a federally mandated Class I area, sensitive Class II area (as identified on a case-by-case basis by Alaska DEC or a federal land management agency), or population center, location within or proximity to a non-attainment or maintenance area, meteorological or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during NEPA undertaken for the project. c. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the project proponent shall prepare (and submit for BLM approval) an emissions inventory that includes quantified emissions of regulated air pollutants from all direct and indirect sources related to the proposed project, including reasonably foreseeable air pollutant emissions of criteria air pollutants, volatile organic compounds, hazardous air pollutants, and greenhouse gases estimated for each year for the life of the project. The BLM will use this estimated emissions inventory to identify pollutants of concern and to determine the appropriate level of air analysis to be conducted for the proposed project.			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>d. Depending on the significance of the predicted impacts, a lessee proposing a central production facility or other facility with potentially significant impacts on air quality may be required to monitor air pollutant emissions and/or air quality impacts for at least one year of operation. Depending upon the initial monitoring results, the authorized officer may require additional monitoring.
e. If monitoring indicates impacts would cause unnecessary or un-due degradation of the lands or fail to protect health (either directly or through use of subsistence resources), the authorized officer may require changes in the lessee’s activities at any time to reduce these emissions, such as, but not limited to, use of cleaner-burning fuels or installation of additional emission control systems.

Northwest
No comparable provision.</td><td colspan="4">d. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the BLM may require the proponent to provide an emissions reduction plan that includes a detailed description of operator committed measures to reduce project related air pollutant emissions including, but not limited to greenhouse gases and fugitive dust.

e. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the authorized officer may require air quality modeling for purposes of analyzing project direct, indirect or cumulative impacts to air quality. The BLM may require air quality modeling depending on the magnitude of potential air emissions from the project or activity, duration of the proposed action, proximity to a federally mandated Class I area, sensitive Class II area (as identified on a case-by-case basis by Alaska DEC or a federal land management agency), or population center, location within a non-attainment or maintenance area, meteorological or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during NEPA undertaken for the project. The BLM will determine the information required for a project specific modeling analysis through the development of a modeling protocol for each analysis. The authorized officer will consult with appropriate federal, State, and/or local agencies regarding modeling to inform his/her modeling decision and avoid duplication of effort. The modeling shall compare predicted impacts to all applicable local, State, and federal air quality standards and increments, as well as other scientifically defensible significance thresholds (such as impacts to air quality related values, incremental cancer risks, etc.).

f. The BLM may require air quality mitigation measures and strategies within its authority (and in consultation with local, state, federal, and tribal agencies with responsibility for managing air resources) in addition to regulatory requirements and proponent committed emission reduction measures, and for emission sources not otherwise regulated by Alaska DEC or EPA, if the air quality analysis shows potential future impacts to NAAQS or AAAQS or impacts above specific levels of concern for air quality related values (AQRVs).

g. If ambient air monitoring indicates that project-related emissions are causing or contributing to impacts that would cause unnecessary or undue degradation of the lands, cause exceedances of NAAQS, or fail to protect health (either directly or through use of subsistence resources), the authorized officer may require changes in activities at any time to reduce these emissions to comply with the NAAQS and/or minimize impacts to AQRVs. Within the scope of BLM’s authority, the BLM may require additional emission control strategies to minimize or reduce impacts to air quality.

h. (Alternative B-2 only) Publicly available reports on air quality baseline monitoring, emissions inventory, and modeling results developed in conformance with this best management procedure shall be provided by the project proponent to the North Slope Borough and to local communities and tribes in a timely manner.</td></tr>
</table>

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-11 Required Operating Procedure **Northeast** Objective: Ensure that permitted activities do not create human health risks through contamination of subsistence foods. Requirement/Standard: A lessee proposing a permanent oil and gas development shall design and implement a monitoring study of contaminants in locally-used subsistence foods. The monitoring study shall examine subsistence foods for all contaminants that could be associated with the proposed development. The study shall identify the level of contaminants in subsistence foods prior to the proposed permanent oil and gas development and monitor the level of these contaminants throughout the operation and abandonment phases of the development. If ongoing monitoring detects a measurable and persistent increase in a contaminant in subsistence foods, the lessee shall design and implement a study to determine how much, if any, of the increase in the contaminant in subsistence foods originates from the lessee's activities. If the study determines that a portion of the increase in contamination in subsistence foods is caused by the lessee's activities, the authorized officer may require changes in the lessee's processes to reduce or eliminate emissions of the contaminant. The design of the study/studies must meet the approval of the authorized officer. The authorized officer may consult with appropriate federal, State, and North Slope Borough agencies prior to approving the study/studies design. The authorized officer may require/authorize changes in the design of the studies throughout the operations and abandonment period, or terminate or suspend studies if results warrant. **Northwest** No comparable provision.	***A-11 Best Management Practice*** Objective: Ensure that permitted activities do not create human health risks through contamination of subsistence foods. Requirement/Standard: A lessee proposing a permanent oil and gas development shall design and implement a monitoring study of contaminants in locally-used subsistence foods. The monitoring study shall examine subsistence foods for all contaminants that could be associated with the proposed development. The study shall identify the level of contaminants in subsistence foods prior to the proposed permanent oil and gas development and monitor the level of these contaminants throughout the operation and abandonment phases of the development. If ongoing monitoring detects a measurable and persistent increase in a contaminant in subsistence foods, the lessee shall design and implement a study to determine how much, if any, of the increase in the contaminant in subsistence foods originates from the lessee's activities. If the study determines that a portion of the increase in contamination in subsistence foods is caused by the lessee's activities, the authorized officer may require changes in the lessee's processes to reduce or eliminate emissions of the contaminant. The design of the study/studies must meet the approval of the authorized officer. The authorized officer may consult with appropriate federal, State, and North Slope Borough agencies prior to approving the study/studies design. The authorized officer may require/authorize changes in the design of the studies throughout the operations and abandonment period, or terminate or suspend studies if results warrant. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
No comparable provision.	***A-12 Best Management Practice*** **NOTE**: **This best management practice is applicable only to Alternative B-2**. There would be no comparable provision for any of the other alternatives. Objective: To minimize negative health impacts associated with oil spills. Requirement/Standard: If an oil spill with potential impacts to public health occurs, the BLM, in undertaking its oil spill responsibilities, will consider: a. Immediate health impacts and responses for affected communities and individuals. b. Long-term monitoring for contamination of subsistence food sources. c. Long-term monitoring of potential human health impacts. d. Perceptions of contamination and subsequent changes in consumption patterns. e. Health promotion activities and communication strategies to maintain the consumption of traditional food.			

WATER USE FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
B-1 Required Operating Procedure **Northeast** Objective: Maintain populations of, and adequate habitat for, fish and invertebrates. Requirement/Standard: Water withdrawal from rivers and streams during winter is prohibited. **Northwest** Same	***B-1 Best Management Practice*** Objective: Maintain populations of, and adequate habitat for, fish and invertebrates. Requirement/Standard: Withdrawal of unfrozen water from rivers and streams during winter is prohibited. The removal of ice aggregate from grounded areas ≤4-feet deep may be authorized from rivers on a site-specific basis.			
B-2 Required Operating Procedure Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish and invertebrates, and waterfowl. Requirement/Standard: Water withdrawal from lakes may be authorized on a site-specific basis depending on water volume and depth, and fish population and species diversification. Current water withdrawal requirements specify: a. Lakes that are ≥7 feet with sensitive fish (any fish except ninespine stickleback or Alaska blackfish), water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; lakes that are between 5 and 7 feet with sensitive fish,	***B-2 Best Management Practice*** Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl. Requirement/Standard: Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas ≤4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community. Current water use requirements are: a. Lakes with sensitive fish (i.e., any fish except ninespine stickleback or Alaska blackfish): unfrozen water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; only ice aggregate may be removed from lakes that are ≤7-feet deep.			

WATER USE FOR PERMITTED ACTIVITIES

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>water available for withdrawal would be calculated on a case-by-case basis.
b. Lakes that are ≥5feet with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish), water available for withdrawal is limited to 30% of calculated volume deeper than 5 feet.
c. Any lake with no fish present, regardless of depth, water available for withdrawal is up to 35% as specified within the permit.
d. A water-monitoring plan may be required to assess drawdown and water quality changes before, during, and after pumping any fish-bearing lake or lake of special concern.
e. The removal of naturally grounded ice may be authorized from lakes and shallow rivers on a site-specific basis depending upon its size, water volume, and depth, and fish population and species diversification.
f. Removed ice aggregate shall be included in the 15% or 30% withdrawal limits—whichever is appropriate—unless otherwise approved.
g. Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. Note: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the Alaska Department of Natural Resources. [Note: Responsibility in the State for such approval now rests with the Alaska Department of Fish and Game, Division of Habitat.]
h. Compaction of snow cover or snow removal from fish-bearing waterbodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.

Northwest
<u>Objective</u>: Maintain natural hydrologic regimes in soils surrounding lakes and ponds and maintain populations of, and adequate habitat for, fish and invertebrates.
<u>Requirement/Standard</u>: Water withdrawal from lakes may be authorized on a site-specific basis depending on size, water volume, and depth, and fish population and species diversification. Current water withdrawal requirements specify:
a. Water withdrawals from any fish bearing lake 7 feet or deeper shall be limited to 15 percent of the estimated free</td><td colspan="4">b. Lakes with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish): unfrozen water available for withdrawal is limited to 30% of calculated volume deeper than 5 feet; only ice aggregate may be removed from lakes that are ≤5.
c. Lakes with no fish present, regardless of depth: water available for use is limited to 35% of total lake volume.
d. In lakes where unfrozen water and ice aggregate are both removed, the total use shall not exceed the respective 15%, 30%, or 35% volume calculations.
e. Additional modeling or monitoring may be required to assess water level and water quality conditions before, during, and after water use from any fish-bearing lake or lake of special concern.
f. Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. Note: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the Alaska Department of Fish and Game, Division of Habitat.
g. Compaction of snow cover or snow removal from fish-bearing waterbodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.</td></tr>
</table>

WATER USE FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
water volume located beneath the ice. b. Water withdrawals from lakes with depths between 5 and 7 feet that contain only ninespine stickleback and/or Alaska blackfish are limited to up to 30 percent of the under-ice volume. c. Water withdrawal may be authorized from any lake if the proponent demonstrates that no fish exist in the lake. d. A water-monitoring plan may be required to assess drawdown and water quality changes before, during, and after pumping any fish-bearing lake. e. Same. f. Same. g. Any water intake structures in fish-bearing waters shall be designed, operated and maintained to prevent fish entrapment, entrainment, or injury. h. Same.				

WINTER OVERLAND MOVES AND SEISMIC WORK

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
The following required operating procedures/best management practices apply to overland moves, seismic work, and any similar cross-country vehicle use of heavy equipment on non-roaded surfaces during the winter season. These restrictions do not apply to the use of such equipment on ice roads after they are constructed.				
C-1 Required Operating Procedure **Northeast** Objective: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations. Requirement/Standard: a. Cross-country use of heavy equipment and seismic activities is prohibited within 0.5 mile of occupied grizzly bear dens identified by the Alaska Department of Fish and Game unless alternative protective measures are approved by the authorized officer in consultation with the Alaska Department of Fish and Game. b. Cross-country use of heavy equipment and seismic activities is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators shall consult with the USFWS and/or NOAA Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15. **Northwest** Same.	***C-1 Best Management Practice*** Objective: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations. Requirement/Standard: a. Cross-country use of heavy equipment and seismic activity is prohibited within 0.5 mile of occupied grizzly bear dens identified by the Alaska Department of Fish and Game unless alternative protective measures are approved by the authorized officer in consultation with the Alaska Department of Fish and Game. b. Cross-country use of heavy equipment and seismic activity is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators near coastal areas shall conduct a survey for potential polar bear dens and seal birthing lairs and consult with the USFWS and/or NOAA Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

WINTER OVERLAND MOVES AND SEISMIC WORK

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
C-2 Required Operating Procedure **Northeast** Objective: Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation. Requirement/Standard: a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and approximately May 15 in the northern coastal areas). The exact dates will be determined by the authorized officer. b. Only low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. A list of approved vehicles can be obtained from the authorized officer. Limited use of tractors equipped with wide tracks or “shoes” will be allowed to pull trailers, sleighs or other equipment with approved undercarriage. **Note:** This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction. c. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed. d. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons. e. The location of winter ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year. f. Motorized ground-vehicle use within the Colville River Special Area associated with overland moves, seismic work, and any similar use of heavy equipment shall be minimized within the Colville River Raptor, Passerine, and Moose Area from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain 0.5 mile away from known	***C-2 Best Management Practice*** Objective: Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation. Requirement/Standard: a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and approximately May 15 in the northern coastal areas). The exact dates will be determined by the authorized officer. b. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Low-ground-pressure vehicles shall be selected and operated in a manner that eliminates direct impacts to the tundra by shearing, scraping, or excessively compacting the tundra mat. **Note**: This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction. c. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed. d. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons. e. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year. f. Motorized ground-vehicle use within the Colville River Special Area associated with overland moves, seismic work, and any similar use of heavy equipment shall be minimized within an area that extends 1 mile west or northwest of the bluffs of the Colville River, and 2 miles on either side of the Kogosukruk and Kikiakrorak rivers and tributaries of the Kogosukruk River from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain 0.5 mile away from known raptor nesting sites, unless authorized by the authorized officer.			

WINTER OVERLAND MOVES AND SEISMIC WORK

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
raptor nesting sites, unless authorized by the authorized officer. [The Colville River Raptor, Passerine, and Moose Area extends 1 mile west or northwest of the bluffs of the Colville River, from approximately Ocean Point to the southern end of the Northeast NPR-A planning area and 2 miles on either side of the Kogosukruk and Kikiakrorak rivers and tributaries of the Kogosukruk River.] **Northwest** Same, except lacks subpart f. **Colville River Special Area Management Plan Protection 7** Objective: Minimize disturbance impacts to nesting arctic peregrine falcons in the Colville River Special Area from motorized ground-vehicle use. Requirement/Standard Motorized ground-vehicle use within the Colville River Special Area authorized by BLM shall be minimized within 1 mile of any known arctic peregrine falcon nest from April 15 through August 15. Such use shall be prohibited within 0.5 mile of nests during the same period unless an exception is granted by BLM.	*(Colville River Special Area Management Plan Protection 7 would not be changed.)*			
C-3 Required Operating Procedure **Northeast** Objective: Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality and protect stream banks. Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Snow and ice bridges shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris. Except at approved crossings, operators are encouraged to travel a minimum of 100 feet from known overwintering fish streams and lakes. **Northwest** Objective: Maintain natural spring runoff patterns, avoid flooding, prevent streambed sedimentation, protect water quality and protect stream banks. Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Snow and ice bridges shall be removed, breached or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.	***C-3 Best Management Practice*** Objective: Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality and protect stream banks. Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.			

WINTER OVERLAND MOVES AND SEISMIC WORK

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>C-4 Required Operating Procedure
Northeast
<u>Objective</u>: Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.
<u>Requirement/Standard</u>: Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers and streams shall be crossed at shallow riffles from point bar to point bar whenever possible.

Northwest
<u>Objective</u>:
Same
<u>Requirement/Standard</u>: Travel up and down streambeds is prohibited. Rivers and streams shall be crossed at shallow riffles from point bar to point bar whenever possible.</td><td colspan="4">C-4 Best Management Practice

<u>Objective</u>: Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.
<u>Requirement/Standard</u>: Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers, streams, and lakes shall be crossed at areas of grounded ice whenever possible.</td></tr>
<tr><td>No comparable provision.</td><td colspan="4">C-5 Best Management Practice

NOTE: This best management practice is only applicable to Alternative B-2. There would be no comparable provision for any of the other alternatives.

<u>Objective</u>: Minimize the effects of high-intensity acoustic energy from seismic surveys on fish..

<u>Requirement/Standard</u>:
a. When conducting vibroseis-based surveys above potential fish overwintering areas (water 6 feet deep or greater, ice plus liquid depth), operators shall follow recommendations by Morris and Winters (2005): only a single set of vibroseis shots should be conducted if possible; if multiple shot locations are required, these should be conducted with minimal delay; multiple days of vibroseis activity above the same overwintering area should be avoided if possible.

b. When conducting air gun-based surveys in freshwater, operators shall follow standard marine mitigation measures that are applicable to fish (e.g., Minerals Management Service 2006): operators will use the lowest sound levels feasible to accomplish their data-collection needs; ramp-up techniques will be utilized (ramp-up involves the gradual increase in emitted sound levels beginning with firing a single air gun and gradually adding air guns until the desired operating level of the full array is obtained).

c. When conducting explosive-based surveys, operators shall follow setback distances from fish-bearing waterbodies based on requirements outlined by Alaska Department of Fish and Game (1991).</td></tr>
</table>

OIL AND GAS EXPLORATORY DRILLING

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>D-1 Lease Stipulation
Northeast
<u>Objectives</u>: Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat.
<u>Requirement/Standard</u>: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes.

Northwest
<u>Objectives</u>: Same.
<u>Requirement/Standard</u>: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes, except where the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative.</td><td colspan="4">D-1 Lease Stipulation

<u>Objectives</u>: Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat.
<u>Requirement/Standard</u>: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes.

(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
<tr><td>D-2 Lease Stipulation
Northeast
<u>Objective</u>: Minimize surface impacts from exploratory drilling.
<u>Requirement/Standard</u>: Construction of permanent or gravel oil and gas facilities shall be prohibited for exploratory drilling. Use of a previously constructed road or pad may be permitted if it is environmentally preferred.

Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, ice airstrips, temporary platforms, etc., unless the lessee demonstrates that construction of permanent facilities such as gravel airstrips, storage pads, and connecting roads is environmentally preferable or necessary to carry out exploration more economically.</td><td colspan="4">D-2 Lease Stipulation

<u>Objective</u>: Minimize surface impacts from exploratory drilling.
<u>Requirement/Standard</u>: Construction of permanent or gravel oil and gas facilities shall be prohibited for exploratory drilling. Use of a previously constructed road or pad may be permitted if it is environmentally preferred.

(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
</table>

FACILITY DESIGN AND CONSTRUCTION

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>E-1 Required Operating Procedure
Northeast
<u>Objective</u>: Protect subsistence use and access to traditional subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish and wildlife resources.
<u>Requirement/Standard</u>: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to traditional subsistence hunting and fishing areas. The authorized officer will consult with appropriate federal, State, and North Slope Borough regulatory and resources agencies prior to approving construction of roads. Subject to approval by the authorized officer, the construction, operation and maintenance of oil field roads is the responsibility of the lessee unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity.

Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: All roads must be designed, constructed, maintained and operated to minimize environmental impacts and to protect subsistence use and access to traditional subsistence hunting and fishing areas. Subject to approval by the authorized officer, the construction, operation and maintenance of oil field roads is the responsibility of the lessee. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within the NPR-A.</td><td colspan="4">E-1 Best Management Practice

<u>Objective</u>: Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish and wildlife resources.

<u>Requirement/Standard</u>: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas. The authorized officer will consult with appropriate federal, State, and North Slope Borough regulatory and resources agencies prior to approving construction of roads. Subject to approval by the authorized officer, the construction, operation and maintenance of oil and gas field roads is the responsibility of the lessee unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity.</td></tr>
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FACILITY DESIGN AND CONSTRUCTION

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<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>E-2 Lease Stipulation
Northeast
<u>Objective</u>: Protect fish-bearing waterbodies, water quality, and aquatic habitats.
<u>Requirement/Standard:</u> Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high watermark. Essential pipeline and road crossings will be permitted on a case-by-case basis. Note: Also refer to Area-Specific Stipulations and Required Operating Procedures for Rivers Area (Lease Stipulation K-1) and Deep Water Lakes (Lease Stipulation K-2).
Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and, where feasible, encouraged. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling shall be accomplished through blocking rather than use of a bulldozer.
Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: The design and location of permanent oil and gas facilities within 500 feet of fish-bearing or 100 feet of non-fish-bearing waterbodies will only be approved on a case-by-case basis if the lessee can demonstrate that impacts to fish, water quality, and aquatic and riparian habitats are minimal. (Note: Also refer to Area-Specific Stipulations and Required Operating Procedures for Rivers (Stipulation K-1) and Deep Water Lakes (Stipulation K-2)).</td><td colspan="4">E-2 Lease Stipulation
<u>Objective</u>: Protect fish-bearing waterbodies, water quality, and aquatic habitats.
<u>Requirement/Standard:</u> Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high watermark of fish-bearing waterbodies. Essential pipeline and road crossings will be permitted on a case-by-case basis. Note: Also refer to Area-Specific Stipulations and Best Management Practices for Rivers Area (Lease Stipulation K-1) and Deep Water Lakes (Lease Stipulation K-2).
Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and encouraged. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling shall be accomplished through blocking rather than use of a bulldozer.</td></tr>
<tr><td>E-3 Lease Stipulation
Northeast
<u>Objective</u>: Maintain free passage of marine and anadromous fish and protect subsistence use and access to traditional subsistence hunting and fishing.
<u>Requirement/Standard</u>: Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in consultation with appropriate federal, State, and</td><td colspan="4">E-3 Lease Stipulation
<u>Objective</u>: Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.
<u>Requirement/Standard:</u> Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, shall be required to address the objectives of water quality and free passage of fish.
(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
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FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
North Slope Borough regulatory and resource agencies, shall be required to address the objectives of water quality and free passage of fish. **Northwest** Objective: Maintain free passage of marine and anadromous fish, and protect subsistence use and access to traditional subsistence hunting and fishing. Requirement/Standard: Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program may be required to address the objectives of water quality and free passage of fish.				
E-4 Required Operating Procedure **Northeast** Objective: Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents. Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved quality assurance/quality control plan that is specific to the product transported and shall be constructed to accommodate the best available technology for detecting and preventing corrosion or mechanical defects during routine structural integrity inspections. **Northwest** Objective: Same. Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved quality assurance/quality control plan that is specific to the product transported.	***E-4 Best Management Practice*** Objective: Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents. Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved quality assurance/quality control plan that is specific to the product transported and shall be constructed to accommodate the best available technology for detecting and preventing corrosion or mechanical defects during routine structural integrity inspections. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
E-5 Required Operating Procedure **Northeast** <u>Objective</u>: Minimize impacts of the development footprint. <u>Requirement/Standard</u>: Facilities shall be designed and located to minimize the development footprint to the maximum extent practicable considering environmental, economic, safety, and social impacts. Issues and methods that are to be considered include: (a) use of maximum feasible extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads; (b) sharing facilities with existing development when prudent and technically feasible; (c) collocation of all oil and gas facilities, except airstrips, docks, and seawater-treatment plants, with drill pads; (d) integration of airstrips with roads; (e) use of gravel-reduction technologies, e.g., insulated or pile-supported pads. **Note**: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations. **Northwest** <u>Objective</u>: Same. <u>Requirement/Standard</u>: Facilities shall be designed and located to minimize development footprint to the maximum extent practicable considering environmental, economic, and social impacts. **Note:** Where aircraft traffic is an issue, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.	***E-5 Best Management Practice*** <u>Objective</u>: Minimize impacts of the development footprint. <u>Requirement/Standard</u>: Facilities shall be designed and located to minimize the development footprint. Issues and methods that are to be considered include: (a) use of maximum extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads; (b) sharing facilities with existing development; (c) collocation of all oil and gas facilities, except airstrips, docks, and seawater-treatment plants, with drill pads; (d) integration of airstrips with roads; (e) use of gravel-reduction technologies, e.g., insulated or pile-supported pads, (f) coordination of facilities with infrastructure in support of offshore development. **Note**: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.			
E-6 Required Operating Procedure **Northeast** <u>Objective</u>: Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage. <u>Requirement/Standard</u>: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow. **Note**: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.	***E-6 Best Management Practice*** <u>Objective</u>: Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage. <u>Requirement/Standard</u>: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow. **Note**: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
Northwest Objective: Reduce the potential for ice-jam flooding, erosion, alteration of natural drainage patterns, and restriction of fish passage. Requirement/Standard: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, maintain natural drainage, and minimal adverse effects to natural stream flow. **Note**: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.				
E-7 Required Operating Procedure **Northeast** Objective: Minimize disruption of caribou movement and subsistence use. Requirement/Standard: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in traditional subsistence activities. Listed below are the accepted design practices: a. Above ground pipelines shall be elevated a minimum of 7 feet as measured from the ground to the bottom of the pipeline at vertical support members. b. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required by the authorized officer after consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility). c. A minimum distance of 500 feet between pipelines and roads shall be maintained. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the authorized officer. **Northwest** Objective: Same. Requirement/Standard: Same, except: c. A minimum distance of 500 feet between pipelines and roads should be maintained when feasible. Separating roads from	***E-7 Best Management Practice*** Objective: Minimize disruption of caribou movement and subsistence use. Requirement/Standard: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities. Listed below are the accepted design practices: a. Above-ground pipelines shall be elevated a minimum of 7 feet as measured from the ground to the bottom of the pipeline at vertical support members. b. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required by the authorized officer after consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility). c. A minimum distance of 500 feet between pipelines and roads shall be maintained. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the authorized officer. d. Above-ground pipelines shall have a non-reflective finish.			

FACILITY DESIGN AND CONSTRUCTION

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<tr><td>pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad.</td><td colspan="4"></td></tr>
<tr><td>E-8 Required Operating Procedure
Northeast
<u>Objective</u>: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.
<u>Requirement/Standard</u>: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall be developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies and consider:
a. Locations outside the active floodplain.
b. Design and construction of gravel mine sites within active floodplains to serve as water reservoirs for future use.
c. Potential use of the site for enhancing fish and wildlife habitat.

Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall consider:
a. Locations outside the active floodplain.
b. Design and construction of gravel mine sites within active floodplains to serve as water reservoirs for future use.
c. Potential use of site for enhancing fish and wildlife habitat.</td><td colspan="4">E-8 Best Management Practice

<u>Objective</u>: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.
<u>Requirement/Standard</u>: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall be developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies and consider:

a. Locations outside the active floodplain.
b. Design and construction of gravel mine sites within active floodplains to serve as water reservoirs for future use.
c. Potential use of the site for enhancing fish and wildlife habitat.
d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope.</td></tr>
<tr><td>E-9 Required Operating Procedure
Northeast
<u>Objective</u>: Avoidance of human-caused increases in populations of predators of ground-nesting birds.

<u>Requirement/Standard</u>:
a. Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the authorized officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites.
b. Feeding of wildlife is prohibited and will be subject to non-compliance regulations.</td><td colspan="4">E-9 Best Management Practice

<u>Objective</u>: Avoidance of human-caused increases in populations of predators of ground-nesting birds.

<u>Requirement/Standard</u>:
a. Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the authorized officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites.

b. Feeding of wildlife is prohibited and will be subject to non-compliance regulations.
(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
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FACILITY DESIGN AND CONSTRUCTION

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<tr><td>Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the authorized officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites.</td><td colspan="4"></td></tr>
<tr><td>E-10 Required Operating Procedure
Northeast
<u>Objective</u>: Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.
<u>Requirement/Standard</u>: Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the Federal Aviation Administration.

Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Except for safety lighting, illumination of higher structures shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward. All drilling structures, production facilities, and other structures that exceed 20 feet shall be illuminated as outlined above.</td><td colspan="4">E-10 Best Management Practice

<u>Objective</u>: Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.

<u>Requirement/Standard</u>: Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the Federal Aviation Administration.

(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
<tr><td>E-11 Required Operating Procedure
Northeast
<u>Objective</u>: Minimize the take of species listed under the Endangered Species Act and minimize the disturbance of other species of interest from direct or indirect interaction with oil and gas facilities.
<u>Requirement/Standard</u>: In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development.
Special Conditions in Spectacled and/or Steller’s Eiders Habitats:
a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the USFWS North Slope eider survey area and at least 1</td><td colspan="4">E-11 Best Management Practice

<u>Objective</u>: Minimize the take of bird species, particularly those listed under the Endangered Species Act and BLM Special Status Species from direct or indirect interaction with oil and gas facilities.

<u>Requirement/Standard</u>: In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development.

Special Conditions in Spectacled and/or Steller’s Eiders Habitats:

a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the USFWS North Slope eider survey area and at least 1 year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys.</td></tr>
</table>

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys. Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol during the second week of June.	Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol. Information gained from these surveys shall be used to make infrastructure siting decisions as discussed in subparagraph b, below.			
b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall consult with the USFWS and BLM in the design and placement of roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, construction of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and introduction of high noise levels.	b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall work with the USFWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, location of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and management of high noise levels.			
c. To reduce the possibility of spectacled and/or Steller's eiders colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases which are to be few in number and limited in extent. Exceptions are limited to the following situations, and must be reported to the USFWS when exceptions are authorized: 1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad; 2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or 3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.	c. To reduce the possibility of spectacled and/or Steller's eiders (and, under Alternatives B-1, B-2, and C only, other birds) colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases which are to be few in number and limited in extent. Exceptions are limited to the following situations, and must be reported to the USFWS when exceptions are authorized: 1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad; 2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or 3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.			
d. To reduce the likelihood of spectacled and/or Steller's eiders colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the USFWS.	d. To reduce the likelihood of spectacled and/or Steller's eiders (and, under Alternatives B-1, B-2, and C only, other birds) colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the USFWS.			

FACILITY DESIGN AND CONSTRUCTION

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<tr><td>Special Conditions in Yellow-billed Loon Habitats:
a. Aerial surveys shall be conducted by the lessee for at least 3 years before authorization of construction of facilities proposed for development which are within 1 mile of a lake 25 acres or larger in size. These surveys along shorelines of large lakes shall be conducted following accepted BLM protocol during nesting in late June and during brood rearing in late August.
b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a 1-mile buffer around all recorded nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.
Northwest
<u>Objective:</u> Same.
<u>Requirement/Standard</u>: In accordance with the guidance below, before the approval of facility construction, aerial surveys of breeding pairs of the following species shall be conducted within any area proposed for development.
Spectacled and/or Steller's Eiders:
Same, except:
c. To reduce the possibility of spectacled and/or Steller's eiders from striking above-ground utility lines (power and communication), such lines shall either be buried in access roads, or suspended on vertical support members, to the extend practical. Support wires associated with communication towers, radio antennas, and other similar facilities, shall be clearly marked along their entire length to improve visibility for low-flying birds. Such markings shall be jointly developed through consultation with USFWS.

Yellow-billed Loon:
Same, except:
b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. Current accepted mitigation is a 1-mile buffer around all recorded nest sites and a minimum 500-meter buffer around the remainder of the lake shoreline. Development may be prohibited within buffers or activities curtailed while birds are present.</td><td colspan="4">Special Conditions in Yellow-billed Loon Habitats:
a. Aerial surveys shall be conducted by the lessee for at least 3 years before authorization of construction of facilities proposed for development which are within 1 mile of a lake 25 acres or larger in size. These surveys along shorelines of large lakes shall be conducted following accepted BLM protocol during nesting in late June and during brood rearing in late August.

b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a 1-mile buffer around all recorded nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.

Protections for Birds
a. To reduce the possibility of birds colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases, which are to be few in number and limited in extent. Exceptions are limited to the following situations:
1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;
2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or
3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.
b. To reduce the likelihood of birds colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the USFWS.</td></tr>
</table>

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
E-12 Required Operating Procedure **Northeast** Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities, to conserve important habitat types during development. Requirement/Standard: An ecological land classification map of the development area shall be developed before approval of facility construction. The map will integrate geomorphology, surface form, and vegetation at a scale, level of resolution, and level of positional accuracy adequate for detailed analysis of development alternatives. The map shall be prepared in time to plan one season of ground-based wildlife surveys, if deemed necessary by the authorized officer, before approval of the exact facility location and facility construction. **Northwest** Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities, to conserve important habitat types, including wetlands, during development. Requirement/Standard: Same.	***E-12 Best Management Practice*** Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities, to conserve important habitat types during development. Requirement/Standard: An ecological land classification map of the development area shall be developed before approval of facility construction. The map will integrate geomorphology, surface form, and vegetation at a scale, level of resolution, and level of positional accuracy adequate for detailed analysis of development alternatives. The map shall be prepared in time to plan one season of ground-based wildlife surveys, if deemed necessary by the authorized officer, before approval of the exact facility location and facility construction. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			
E-13 Required Operating Procedure **Northeast** Objective: Protect cultural and paleontological resources. Requirement/Standard: Lessees shall conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. Upon finding any potential cultural or paleontological resource, the lessee or their designated representative shall notify the authorized officer and suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the authorized officer. **Northwest** Same.	***E-13 Best Management Practice*** Objective: Protect cultural and paleontological resources. Requirement/Standard: Lessees shall conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. Upon finding any potential cultural or paleontological resource, the lessee or their designated representative shall notify the authorized officer and suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the authorized officer. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

FACILITY DESIGN AND CONSTRUCTION

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>E-14 Required Operating Procedure
Northeast
<u>Objective</u>: Ensure the passage of fish at stream crossings.
<u>Requirement/Standard</u>: To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the best management practices outlined in “Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain” by McDonald et al. (1994), “Fundamentals of Culvert Design for Passage of Weak-Swimming Fish” by Behlke et al. (1991), and other generally accepted best management procedures prescribed by the authorized officer. To adhere to these best management practices, at least 3 years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream’s ordinary high watermark. These data shall include, but are not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.
Northwest
No comparable provision.</td><td colspan="4">E-14 Best Management Practice
<u>Objective</u>: Ensure the passage of fish at stream crossings.
<u>Requirement/Standard</u>: To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the best management practices outlined in “Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain” by McDonald et al. (1994), “Fundamentals of Culvert Design for Passage of Weak-Swimming Fish” by Behlke et al. (1991), and other generally accepted best management procedures prescribed by the authorized officer. To adhere to these best management practices, at least 3 years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream’s ordinary high watermark. These data shall include, but are not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.
(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
<tr><td>E-15 Required Operating Procedure
Northeast
<u>Objective</u>: Prevent or minimize the loss of nesting habitat for cliff nesting raptors.
<u>Requirement/Standard</u>:
a. Removal of greater than 100 cubic yards of sand and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.
Northwest
No comparable provision.
Colville River Special Area Management Plan Protection 9
<u>Objective</u>: Minimize impacts from sand and/or gravel extraction to arctic peregrine falcons in the Colville River Special Area.
<u>Requirement/Standard</u>: To reduce impacts to arctic peregrine falcons in the Colville River Special Area from sand or gravel extraction the following measures apply:</td><td colspan="4">E-15 Best Management Practice
<u>Objective</u>: Prevent or minimize the loss of nesting habitat for cliff nesting raptors.
<u>Requirement/Standard</u>:
a. Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.
(Text is same as in Northeast NPR-A 2008 Record of Decision)
(Colville River Special Area Management Plan Protection 9 would not be changed.)</td></tr>
</table>

FACILITY DESIGN AND CONSTRUCTION

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>a. Removal of greater than 100 cubic yards of sand and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.</td><td colspan="4"></td></tr>
<tr><td>E-16 Required Operating Procedure
Northeast
<u>Objective</u>: Prevent or minimize the loss of raptors due to electrocution by powerlines.
<u>Requirement/Standard</u>: Comply with the most up-to-date industry-accepted suggested practices for raptor protection on powerlines. Current accepted standards were published in “Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006” in 2006 by the Avian Power Line Interaction Committee and are updated as needed.

Northwest
No comparable provision.

Colville River Special Area Management Plan-Protection 8
<u>Objective</u>: Minimize impacts to arctic peregrine falcon in the CRSA from power lines.
<u>Requirement/Standard</u>: To minimize impacts to arctic peregrine falcons in the Colville River Special Area from the powerlines, construction projects will comply with the most up-to-date suggested practices for arctic peregrine falcon protection on powerlines. All powerlines and poles shall be designed and constructed in a manner which reflects safe configurations to prevent death of arctic peregrine falcons by electrocution.</td><td colspan="4">E-16 Best Management Practice

<u>Objective</u>: Prevent or minimize the loss of raptors due to electrocution by powerlines.
<u>Requirement/Standard</u>: Comply with the most up-to-date industry-accepted suggested practices for raptor protection on powerlines. Current accepted standards were published in “Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006” in 2006 by the Avian Power Line Interaction Committee and are updated as needed.
(Text is same as in Northeast NPR-A 2008 Record of Decision)

(Colville River Special Area Management Plan Protection 8 would not be changed.)</td></tr>
<tr><td>E-17 Stipulation/Required Operating Procedure
Northeast
(This measure is to be incorporated as a stipulation in new and renewed leases. It is a required operating procedure for existing leases and will be required for any relevant permanent facilities.)
<u>Objective</u>: Minimize impacts to important spectacled eider nesting habitat.
<u>Requirement/Standard:</u> With the exception of pipelines, no (a) permanent oil and gas facilities, (b) material sites, or (c) staging areas that would occupy land through more than one winter season would be permitted in spectacled eider nesting and breeding habitat identified by the USFWS as being “high” density</td><td colspan="4">E-17 Stipulation/Best Management Practice

No comparable provision. (See E-11 Best Management Practice)</td></tr>
</table>

FACILITY DESIGN AND CONSTRUCTION

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>(>1.06 eiders per square mile) using the best available long-term data from the Annual Eider Breeding Survey at the time development is proposed.

Northwest
No comparable provision.</td><td colspan="4"></td></tr>
<tr><td>E-18 Required Operating Procedure
Northeast
<u>Objective</u>: Avoid and reduce temporary impacts to productivity from disturbance near Steller’s and/or spectacled eider nests.
<u>Requirement/Standard</u>: Ground-level activity (by vehicle or on foot) within 200 meters of occupied Steller’s and/or spectacled eider nests, from June 1 through August 15, will be restricted to existing thoroughfares, such as pads and roads. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 meters of occupied Steller’s and/or spectacled eider nests will be prohibited. In instances where summer (June 1 through August 15) support/construction activity must occur off existing thoroughfares, USFWS-approved nest surveys must be conducted during mid-June prior to the approval of the activity. Collected data would be used to evaluate whether the action could occur based on employment of a 200-meter buffer around nests or if the activity would be delayed until after mid-August once ducklings are mobile and have left the nest site. The BLM will also work with the USFWS to schedule oil spill response training in riverine, marine, and inter-tidal areas that occurs within 200 meters of shore outside sensitive nesting/brood-rearing periods or conduct nest surveys. The protocol and timing of nest surveys for Steller’s and/or spectacled eiders will be determined in cooperation with the USFWS, and must be approved by the USFWS. Surveys should be supervised by biologists who have previous experience with Steller’s and/or spectacled eider nest surveys.

Northwest
No comparable provision.</td><td colspan="4">E-18 Best Management Practice

<u>Objective</u>: Avoid and reduce temporary impacts to productivity from disturbance near Steller’s and/or spectacled eider nests.
<u>Requirement/Standard</u>: Ground-level activity (by vehicle or on foot) within 200 meters of occupied Steller’s and/or spectacled eider nests, from June 1 through August 15, will be restricted to existing thoroughfares, such as pads and roads. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 meters of occupied Steller’s and/or spectacled eider nests will be prohibited. In instances where summer (June 1 through August 15) support/construction activity must occur off existing thoroughfares, USFWS-approved nest surveys must be conducted during mid-June prior to the approval of the activity. Collected data will be used to evaluate whether the action could occur based on employment of a 200-meter buffer around nests or if the activity would be delayed until after mid-August once ducklings are mobile and have left the nest site. The BLM will also work with the USFWS to schedule oil spill response training in riverine, marine, and inter-tidal areas that occurs within 200 meters of shore outside sensitive nesting/brood-rearing periods or conduct nest surveys. The protocol and timing of nest surveys for Steller’s and/or spectacled eiders will be determined in cooperation with the USFWS, and must be approved by the USFWS. Surveys should be supervised by biologists who have previous experience with Steller’s and/or spectacled eider nest surveys.

(Text is same as in Northeast NPR-A 2008 Record of Decision)</td></tr>
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FACILITY DESIGN AND CONSTRUCTION

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<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>No comparable provision.</td><td colspan="4">E-19 Best Management Practice
<u>Objective</u>: Provide information to be used in monitoring and assessing wildlife movements during and after construction.
<u>Requirement/Standard</u>: A representation, in the form of ArcGIS-compatible shape-files, of all new infrastructure construction shall be provided to the authorized officer. During the planning and permitting phase, shape-files representing proposed locations shall be provided. Within 6 months of construction completion, shape-files (within GPS accuracy) of all new infrastructure shall be provided. Infrastructure includes all gravel roads and pads, facilities built on pads, pipelines and independently constructed powerlines (as opposed to those incorporated in pipeline design). Gravel pads shall be included as polygon feature. Roads, pipelines, and powerlines may be represented as line features but must include ancillary data to denote width, number pipes, etc. Poles for power lines may be represented as point features. Ancillary data shall include construction beginning and ending dates.</td></tr>
<tr><td>No comparable provision.</td><td colspan="4">E-20 Best Management Practice
NOTE: This best management practice is only applicable to Alternative B-2. There would be no comparable provision for any of the other alternatives.
<u>Objective</u>: Manage permitted activities to meet Visual Resource Management class objectives described below.
Class I: Natural ecological changes and very limited management activity are allowed. The level of change to the characteristic landscape should be very low and must not attract attention.
Class II: The level of change to the characteristic landscape should be low. Management activities may be seen, but should not dominate the view of the casual observer. Any changes should repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III: The level of change to the characteristic landscape should be moderate. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV: The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize impacts through location and design by repeating form, line, color, and texture.
<u>Requirement/Standard</u>: At the time of application for construction of permanent facilities, the lessee/permittee shall, after consultation with the authorized officer, submit a plan to best minimize visual impacts, consistent with the Visual Resource Management class for the lands on which facilities would be located. A photo simulation of the proposed facilities may be a necessary element of the plan.</td></tr>
</table>

USE OF AIRCRAFT FOR PERMITTED ACTIVITIES

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>F-1 Required Operating Procedure
Northeast
<u>Objective</u>: Minimize the effects of low-flying aircraft on wildlife, traditional subsistence activities, and local communities.
<u>Requirement/Standard</u>: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines (Note: This required operating procedure is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the stipulations and required operating procedures. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.):
a. Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within 0.5 mile of cliffs identified as raptor nesting sites from April 15 through August 15 and within 0.5 mile of known gyrfalcon nest sites from March 15 to August 15, unless doing so would endanger human life or violate safe flying practices. Permittees shall obtain information from the BLM necessary to plan flight routes when routes may go near falcon nests.
b. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the authorized officer. The authorized officer will consult directly with the Alaska Department of Fish and Game in annually defining caribou winter ranges.
c. Land user shall submit an aircraft use plan as part of an oil and gas exploration or development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Proposed aircraft use plans should be reviewed by appropriate federal, State, and borough agencies. Consultations with these same agencies will be required if unacceptable disturbance is identified by subsistence users. Adjustments, including possible suspension of all flights, may be required by the authorized officer if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies</td><td colspan="4">F-1 Best Management Practice
<u>Objective</u>: Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.
<u>Requirement/Standard</u>: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines (Note: This best management practice is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.):
a. Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within 0.5 mile of cliffs identified as raptor nesting sites from April 15 through August 15 and within 0.5 mile of known gyrfalcon nest sites from March 15 to August 15, unless doing so would endanger human life or violate safe flying practices. Permittees shall obtain information from the BLM necessary to plan flight routes when routes may go near falcon nests.
b. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the authorized officer. The BLM will consult directly with the Alaska Department of Fish and Game in annually defining caribou winter ranges.
c. Land user shall submit an aircraft use plan as part of an oil and gas exploration or development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Proposed aircraft use plans should be reviewed by appropriate federal, State, and borough agencies. Consultations with these same agencies will be required if unacceptable disturbance is identified by subsistence users. Adjustments, including possible suspension of all flights, may be required by the authorized officer if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility.</td></tr>
</table>

USE OF AIRCRAFT FOR PERMITTED ACTIVITIES

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered so as to allow larger aircraft to be employed, resulting in fewer flights to the facility.

d. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum.
e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area [Map 2-1K] from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area [Map 2-1K] should be minimized from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.

Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Same, except:
The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines:
b. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the authorized officer.
c. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered so as to allow larger aircraft to be employed, resulting in a fewer number of flights to the facility.
e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Caribou Study Area (See Map 2-1K]) from June 15 through July 31, unless doing so would endanger human life or violate safe flying practices.
f. Aircraft shall maintain an altitude of at least 2,000 feet above</td><td colspan="4">

d. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum.

e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area (Maps 2-3K and 2-4K, depending upon alternative) from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area (Maps 2-3K or 2-4K) should be minimized from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.
f. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Utukok River Uplands Special Area from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. (Note: The boundary of the Utukok River Uplands Special Area differs among Alternatives B-1 through D. See Maps 2-2, 2-3, and 2-4.)
g. (Alternative B-2 only) Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away.
h. (Alternative B-2 only) Fixed wing aircraft used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 2,000 feet and a 0.5-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices. Helicopters used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices.
i. (Alternative B-2 only) Aircraft used as part of a BLM-authorized activity along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet and a buffer of 1 mile from aggregations of seals, unless doing so would endanger human life or violate safe flying practices.</td></tr>
</table>

USE OF AIRCRAFT FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
ground level (except for takeoffs and landings) over the Caribou Coastal Insect-Relief Areas (Map 91 in the Northwest NPR-A Final IAP/EIS [i.e., the 0.75-mile coastal area identified in Stipulation K-6]) from June 15 through July 31, unless doing so would endanger human life or violate safe flying practices.				
Colville River Special Area Management Plan-Protection 3 Objective: Minimize the effects of low-flying aircraft on arctic peregrine falcons in the Colville River Special Area. Requirement/Standard: To minimize disturbance to nesting arctic peregrine falcons, aircraft authorized by BLM are required to maintain an altitude of at least 1,500 feet above ground level when within 0.5 mile of cliffs identified as arctic peregrine falcon nesting sites from April 15 through August 15. This protection is not intended to restrict flights necessary to conduct wildlife surveys to obtain information necessary to satisfy wildlife data collection requirements. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.	*(Colville River Special Area Management Plan Protection 3 would not be changed.)*			

OIL AND GAS FIELD ABANDONMENT

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
G-1 Lease Stipulation **Northeast** Objective: Ensure the final disposition of the land meets the current and future needs of the public. Requirement/Standard: Upon abandonment or expiration of the lease, all oil- and gas-related facilities shall be removed and sites rehabilitated to as near the original condition as practicable, subject to the review of the authorized officer. The authorized officer may determine that it is in the best interest of the public to retain some or all facilities. Within the Goose Molting Area, the authorized officer, when determining if it is in the best interest of the public to retain a facility, will consider the impacts of retention to molting geese and goose molting habitat. **Northwest** Objective: Same. Requirement/Standard: Upon abandonment or expiration of the	***G-1 Lease Stipulation*** Objective: Ensure long-term reclamation of land to its previous condition and use. Requirement/Standard: Prior to final abandonment, land used for oil and gas infrastructure—including but not limited to well pads, production facilities, access roads, and airstrips—shall be reclaimed to ensure eventual restoration of ecosystem function. The leaseholder shall develop and implement an abandonment and reclamation plan approved by the BLM. The plan shall describe short-term stability, visual, hydrological, and productivity objectives and steps to be taken to ensure eventual ecosystem restoration to the land's previous hydrological, vegetative, and habitat condition. The BLM may grant exceptions to satisfy stated environmental or public purposes.			

OIL AND GAS FIELD ABANDONMENT

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>lease, all oil- and gas-related facilities shall be removed and sites rehabilitated to as near the original condition as practicable, subject to the review of the authorized officer. The authorized officer may determine that it is in the best interest of the public to retain some or all facilities.</td><td colspan="4"></td></tr>
</table>

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>H-1 Required Operating Procedure
Northeast
<u>Objective</u>: Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and oil and gas and related activities.
<u>Requirement/Standard</u>: Lessee/permittee shall consult directly with affected communities using the following guidelines:
a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the North Slope Borough, and the National Petroleum Reserve-Alaska Subsistence Advisory Panel to discuss the siting, timing, and methods of their proposed operations to help discover local traditional and scientific knowledge, resulting in measures that minimize impacts to subsistence uses. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities.
b. The applicant shall submit documentation of consultation efforts as part of its operations plan. Applicants should submit the proposed plan of operations to provide an adequate time for review and comment by the National Petroleum Reserve-Alaska Subsistence Advisory Panel and to allow time for formal government-to-government consultation with Native Tribal governments. The applicant shall submit documentation of its consultation efforts and a written plan that shows how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Operations plans must include a discussion of the potential effects of the proposed operation,</td><td colspan="4">H-1 Best Management Practice

<u>Objective</u>: Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.

<u>Requirement/Standard</u>: Lessee/permittee shall consult directly with affected communities using the following guidelines:
a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the North Slope Borough, and the National Petroleum Reserve-Alaska Subsistence Advisory Panel to discuss the siting, timing and methods of their proposed operations to help discover local traditional and scientific knowledge, resulting in measures that minimize impacts to subsistence uses. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities. In the event that no agreement is reached between the parties, the authorized officer shall consult with the directly involved parties and determine which activities will occur, including the timeframes.

b. The applicant shall submit documentation of consultation efforts as part of its operations plan. Applicants should submit the proposed plan of operations to the National Petroleum Reserve-Alaska Subsistence Advisory Panel for review and comment. The applicant must allow time for the BLM to conduct formal government-to-government consultation with Native Tribal governments if the proposed action requires it.</td></tr>
</table>

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>and the proposed operation in combination with other existing or reasonably foreseeable operations.

c. A subsistence plan addressing the following items must be submitted:
1. A detailed description of the activity(ies) to take place (including the use of aircraft).
2. A description of how the lessee/permittee will minimize and/or deal with any potential impacts identified by the authorized officer during the consultation process.
3. A detailed description of the monitoring effort to take place, including process, procedures, personnel involved and points of contact both at the work site and in the local community.
4. Communication elements to provide information on how the applicant will keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community meetings, open house meetings, workshops, newsletters, radio and television announcements, etc.
5. Procedures necessary to facilitate access by subsistence users to conduct their activities.
In the event that no agreement is reached between the parties, the authorized officer shall consult with the directly involved parties and determine which activities will occur, including the timeframes. During development, monitoring plans must be established for new permanent facilities, including pipelines, to assess an appropriate range of potential effects on resources and subsistence as determined on a case-by-case basis given the nature and location of the facilities. The scope, intensity, and duration of such plans will be established in consultation with the authorized officer and NPR-A Subsistence Advisory Panel. Permittees that propose barging facilities, equipment, supplies, or other materials to NPR-A in support of oil and gas activities in the [Northeast NPR-A] planning area shall notify, confer, and coordinate with the Alaska Eskimo Whaling Commission, the appropriate local community whaling captains' associations, and the North Slope Borough to minimize impacts from the proposed barging on subsistence whaling activities.</td><td colspan="4">c. A plan shall be developed that shows how the activity, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. The plan will also describe the methods used to monitor the effects of the activity on subsistence use. The plan shall be submitted to the BLM as part of the plan of operations. The plan should address the following items:
1. A detailed description of the activity(ies) to take place (including the use of aircraft).
2. A description of how the lessee/permittee will minimize and/or deal with any potential impacts identified by the authorized officer during the consultation process.
3. A detailed description of the monitoring effort to take place, including process, procedures, personnel involved and points of contact both at the work site and in the local community.
4. Communication elements to provide information on how the applicant will keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community meetings, open house meetings, workshops, newsletters, radio and television announcements, etc.
5. Procedures necessary to facilitate access by subsistence users to conduct their activities.
6. (Alternative B-2 only) Barge operators requiring a BLM permit are required to demonstrate that barging activities will not have unmitigable adverse impacts on the availability of marine mammals to subsistence hunters.
7. (Alternative B-2 only) All vessels over 50 ft. in length engaged in operations requiring a BLM permit must have an Automatic Identification System (AIS) transponder system on the vessel.

d. During development, monitoring plans must be established for new permanent facilities, including pipelines, to assess an appropriate range of potential effects on resources and subsistence as determined on a case-by-case basis given the nature and location of the facilities. The scope, intensity, and duration of such plans will be established in consultation with the authorized officer and NPR-A Subsistence Advisory Panel.

e. Permittees that propose barging facilities, equipment, supplies, or other materials to NPR-A in support of oil and gas activities in the NPR-A shall notify, confer, and coordinate with the Alaska Eskimo Whaling Commission, the appropriate local community whaling captains' associations, and the North Slope Borough to minimize impacts from the proposed barging on subsistence whaling activities.</td></tr>
</table>

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Same, except:
a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the North Slope Borough, and the NPR-A Subsistence Advisory Panel to discuss the siting, timing and methods of proposed operations. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities.
Note: The final unnumbered paragraph in the Northeast NPR-A Record of Decision is not included in the Northwest NPR-A Record of Decision, but the wording of the first sentence is included in numbered bullet 6 and the next two sentences are in numbered bullet 7. There is no comparable statement to the last sentence in the paragraph.</td><td colspan="4"></td></tr>
<tr><td>H-2 Required Operating Procedure
Northeast
<u>Objective</u>: Prevent unreasonable conflicts between subsistence activities and geophysical (seismic) exploration.
<u>Requirement/Standard</u>: In addition to the consultation process described in Required Operating Procedure H-1 for permitted activities, before applying for permits to conduct geophysical (seismic) exploration, the applicant shall (1) consult with local communities and residents and (2) notify the local search and rescue organizations of current and recent seismic surveys. For the purpose of this standard, a potentially affected cabin/campsite is defined as any camp or campsite within the boundary of the area subject to proposed geophysical exploration and/or within 1 mile of actual or planned travel routes used to supply the seismic operations while it is in operation.
a. Because of the large land area covered by typical geophysical operations and the potential to impact a large number of subsistence users during the exploration season, the permittee/operator will notify in writing all potentially affected long-term cabin and camp users.
b. The official recognized list of cabin and campsite users is the North Slope Borough’s 2001 (or most current) inventory of cabins and campsites.</td><td colspan="4">H-2 Best Management Practice
<u>Objective</u>: Prevent unreasonable conflicts between subsistence activities and geophysical (seismic) exploration.
<u>Requirement/Standard</u>: In addition to the consultation process described in Best Management Practice H-1 for permitted activities, before activity to conduct geophysical (seismic) exploration commences, applicants shall notify the local search and rescue organizations of proposed seismic survey locations for that operational season. For the purpose of this standard, a potentially affected cabin/campsite is defined as any camp or campsite used for subsistence purposes and located within the boundary of the area subject to proposed geophysical exploration and/or within 1 mile of actual or planned travel routes used to supply the seismic operations while it is in operation.
a. Because of the large land area covered by typical geophysical operations and the potential to impact a large number of subsistence users during the exploration season, the permittee/operator will notify all potentially affected subsistence-use cabin and campsite users.
b. The official recognized list of subsistence-use cabin and campsite users is the North Slope Borough’s most current inventory of cabins and campsites, which have been identified by the subsistence users’ names.</td></tr>
</table>

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
c. A copy of the notification letter and a list of potentially affected users shall also be provided to the office of the appropriate Native Tribal government. d. The authorized officer will prohibit seismic work within 1 mile of any known, long-term, cabin or campsite unless an alternate agreement between the cabin/campsite owner/user is reached through the consultation process and presented to the authorized officer. (Regardless of the consultation outcome, the authorized officer will prohibit wintertime seismic work within 300 feet of a known long-term cabin or campsite.) e. The permittee shall notify the appropriate local search and rescue (e.g., Nuiqsut Search and Rescue, Atqasuk Search and Rescue) of their current operational location within the NPR-A on a weekly basis. This notification should include a map indicating the current extent of surface use and occupation, as well as areas previously used/occupied during the course of the operation in progress. The purpose of this notification is to allow hunters up-to-date information regarding where seismic exploration is occurring, and has occurred, so that they can plan their hunting trips and access routes accordingly. Identification of the appropriate search and rescue offices to be contacted can be obtained from the NPR-A Subsistence Advisory Panel. **Northwest** Objective: Same. Requirement/Standard: Same, except: In addition to the consultation process described above for permitted activities**,** before applying for permits to conduct geophysical (seismic) exploration, the applicant shall consult with local communities and residents: c. For the purpose of this standard, potentially affected cabins and campsites are defined as any camp or campsite within the boundary of the area subject to proposed geophysical exploration and/or within 1,200 feet of actual or planned travel routes used to supply the seismic operations while it is in operation. d. A copy of the notification letter and a list of potentially affected users shall also be provided to the office of the appropriate Native Tribal Government. e. Based on that consultation, the authorized officer may prohibit seismic work up to 1,200 feet of any known, long-term cabin or campsite. Generally, the authorized officer will allow	c. A copy of the notification letter, a map of the proposed exploration area, and the list of potentially affected users shall also be provided to the office of the appropriate Native Tribal government. d. The authorized officer will prohibit seismic work within 1 mile of any known subsistence-use cabin or campsite unless an alternate agreement between the cabin/campsite owner/user is reached through the consultation process and presented to the authorized officer. (Regardless of the consultation outcome, the authorized officer will prohibit seismic work within 300 feet of a known subsistence-use cabin or campsite.) e. The permittee shall notify the appropriate local search and rescue (e.g., Nuiqsut Search and Rescue, Atqasuk Search and Rescue) of their current operational location within the NPR-A on a weekly basis. This notification should include a map indicating the current extent of surface use and occupation, as well as areas previously used/occupied during the course of the operation in progress. The purpose of this notification is to allow hunters up-to-date information regarding where seismic exploration is occurring, and has occurred, so that they can plan their hunting trips and access routes accordingly. Identification of the appropriate search and rescue offices to be contacted can be obtained from the coordinator of the NPR-A Subsistence Advisory Panel in the BLM's Arctic Field Office.			

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>wintertime seismic work to be conducted within 300 feet of a long-term cabin or campsite that is not in use.</td><td colspan="4"></td></tr>
<tr><td>No comparable provision.</td><td colspan="4">H-3 Best Management Practice
<u>Objective</u>: Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.
<u>Requirement/Standard</u>: Hunting and trapping by lessee's/permittee’ s employees, agents, and contractors are prohibited when persons are on “work status.” Work status is defined as the period during which an individual is under the control and supervision of an employer. Work status is terminated when the individual’s shift ends and he/she returns to a public airport or community (e.g., Fairbanks, Barrow, Nuiqsut, or Deadhorse). Use of lessee/permittee facilities, equipment, or transport for personnel access or aid in hunting and trapping is prohibited.</td></tr>
</table>

ORIENTATION PROGRAMS ASSOCIATED WITH PERMITTED ACTIVITIES

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>I-1 Required Operating Procedure
Northeast
<u>Objective</u>: Minimize cultural and resource conflicts.
<u>Requirement/Standard</u>: All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, required operating procedures, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permittee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year. The proposed orientation program shall be submitted to the authorized officer for review and approval and should:
a. provide sufficient detail to notify personnel of applicable stipulations and required operating procedures as well as inform individuals working on the project of specific types of environmental, social, traditional and cultural concerns that relate to the region.
b. Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance.
c. Include guidance on the preparation, production, and distribution of information cards on endangered and/or threatened species.</td><td colspan="4">I-1 Best Management Practice

<u>Objective</u>: Minimize cultural and resource conflicts.
<u>Requirement/Standard</u>: All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, best management practices, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permittee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year. The proposed orientation program shall be submitted to the authorized officer for review and approval and should:

a. provide sufficient detail to notify personnel of applicable stipulations and best management practices as well as inform individuals working on the project of specific types of environmental, social, traditional and cultural concerns that relate to the region.

b. Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance.

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ORIENTATION PROGRAMS ASSOCIATED WITH PERMITTED ACTIVITIES

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<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>d. Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating.
e. Include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.
f. Include information for aircraft personnel concerning subsistence activities and areas/seasons that are particularly sensitive to disturbance by low-flying aircraft. Of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near North Slope communities.
g. Provide that individual training is transferable from one facility to another except for elements of the training specific to a particular site.
h. Include on-site records of all personnel who attend the program for so long as the site is active, though not to exceed the 5 most recent years of operations. This record shall include the name and dates(s) of attendance of each attendee.
i. Include a module discussing bear interaction plans to minimize conflicts between bears and humans.
j. Provide a copy of 43 CFR 3163 regarding Non-Compliance Assessment and Penalties to onsite personnel.
k. Include training designed to ensure strict compliance with local and corporate drug and alcohol policies. This training should be offered to the North Slope Borough Health Department for review and comment.
l. Include training developed to train employees on how to prevent transmission of communicable diseases, including sexually transmitted diseases, to the local communities. This training should be offered to the North Slope Borough Health Department for review and comment.

Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Same, except that subparagraphs j, k, and l are not included.</td><td colspan="4">d. Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating.
e. Include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.
f. Include information for aircraft personnel concerning subsistence activities and areas/seasons that are particularly sensitive to disturbance by low-flying aircraft. Of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near North Slope communities.
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k. Include training designed to ensure strict compliance with local and corporate drug and alcohol policies. This training should be offered to the North Slope Borough Health Department for review and comment.
l. Include training developed to train employees on how to prevent transmission of communicable diseases, including sexually transmitted diseases, to the local communities. This training should be offered to the North Slope Borough Health Department for review and comment.
(Same text as in Northeast NPR-A 2008 Record of Decision)</td></tr>
</table>

ENDANGERED SPECIES ACT—SECTION 7 CONSULTATION PROCESS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
J. **Northeast** The lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or to have some other special status. The BLM may recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activities that will contribute to the need to list such a species or their habitat. The BLM may require modifications to or disapprove a proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. The BLM will not approve any activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 USC § 1531 et seq., including completion of any required procedure for conference or consultation. **Northwest** Same, except characterized as Stipulation J-1.	***J.*** The lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or to have some other special status. The BLM may require modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activities that will contribute to the need to list such a species or their habitat. The BLM may require modifications to or disapprove a proposed activity that is likely to adversely affect a proposed or listed endangered species, threatened species, or critical habitat. The BLM will not approve any activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 USC § 1531 et seq., including completion of any required procedure for conference or consultation.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
K-1 Lease Stipulation - Rivers **Northeast** Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. (Gravel mines may be located within the active	***K-1 Lease Stipulation/Best Management Practice – Rivers*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternatives, K-1 would be a best management practice. In Alternatives B-1 and B-2, portions of the Colville, Ikpikpuk, Kikiakrorak, Kogosukruk, and Titalik rivers have larger setbacks than in the other alternatives; see below for the details. Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. (Gravel mines may be located within the active floodplain consistent with Best Management Practice E-8). On a case-by case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility),			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

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<tr><td>floodplain consistent with Required Operating Procedure E-8). With the exception of the Ikpikpuk River, these setbacks are measured from the bank of the river as determined by the hydrology at the time of application. The standard setback is 0.5 mile (from the bank’s highest high watermark) and increased to 0.75 mile (from the bank’s highest high watermark) where subsistence cabin and campsites are numerous. Along the Colville River and a portion of the Ikpikpuk a 1-mile (from the bank’s highest high watermark) setback is required to protect important raptor habitat (for locations along rivers where setback distances change). On a case-by case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings to the main channel will be permitted through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event.
a. Colville River: a 1-mile setback from the boundary of NPR-A along the Colville River as determined by cadastral survey to be the highest high watermark on the left (western or northern) bank extending the length of that portion of the river located within the [Northeast NPR-A] planning area. Note: The [Northeast NPR-A] planning area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within National Petroleum Reserve-Alaska.
b. Ikpikpuk River: a 0.75-mile setback from each side of the centerline (1.5 miles total) of the Ikpikpuk River extending from the mouth south to section 19, T7N, R11W, U.M. (Umiat Meridian). From section 19, T7N, R11W, U.M., to section 4, T3N, R12W, U.M., a 1-mile setback is required. Beginning at section 4, T3N, R12W, U.M., a 0.5-mile setback from the centerline (1 mile total) will be required to the confluence of the Kigalik River and Maybe Creek. Note: The setback distances</td>
<td colspan="4">essential pipeline and road crossings to the main channel will be permitted through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event. In the below list, if no upper limit for the setback is indicated, the setback extends to the head of the stream as identified in the National Hydrography Dataset.
a. Colville River: a 1-mile setback (2-mile setback in Alternatives B-1 and B-2) from the boundary of NPR-A where the river determines the boundary along the Colville River as determined by cadastral survey to be the highest high watermark on the left (western or northern) bank and from both banks’ ordinary high watermark where BLM-manages both sides of the river up through T5S, R30W, U.M. Above that point to its source at the juncture of Thunder and Storm creeks the setback will be 0.5 mile. Note: The planning area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes, though the BLM would encourage minimal use of the setback area. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within National Petroleum Reserve-Alaska.
b. Ikpikpuk River: a 0.5-mile setback from of the ordinary high watermark of the Ikpikpuk River extending from the mouth south to section 19, T7N, R11W, U.M. From section 19, T7N, R11W, U.M., to section 4, T3N, R12W, U.M., a 1-mile setback is required. Beginning at section. 4, T3N, R12W, U.M., a 0.5-mile setback from the centerline (1 mile total) will be required to the confluence of the Kigalik River and Maybe Creek. In Alternative B-1 and B-2, the setback would be 2 miles from the ordinary high watermark from the mouth of the river upstream through T7 N, R11W, U.M.; above that point the setback would be the same as described above in Alternative B-1 and 1 mile in Alternative B-2.
c. Miguakiak River: a 0.5-mile setback from the bank’s ordinary high watermark.
d. Kikiakrorak and Kogosukruk Rivers: A 1-mile setback from the top of the bluff (or ordinary high watermark if there is no bluff) on the Kikiakrorak River downstream from T2N., R4W, U.M. and on the Kogosukruk River (including Branch of Kogosukruk River, Henry Creek, and two unnamed tributaries off the southern bank) downstream from T2N, R3W, U.M. In Alternatives B-1 and B-2, the setback would be 2 miles from the top of the bluff (or bank if there is no bluff) for the same waterbodies. The setback from these streams in Alternatives B-1 through D in the named townships and further upstream as applicable will be 0.5 mile from the top of the bluff or bank if there is no bluff.
e. Fish Creek: a 3-mile setback from the bank’s highest high watermark of the creek downstream from the eastern edge of section 31, T11N, R1E., U.M. and a 0.5-mile setback from the bank’s highest high watermark farther upstream.
f. Judy Creek: a 0.5-mile setback from the banks’ ordinary high watermark.
g. Ublutuoch (Tiŋmiaqsiugvik) River: a 0.5-mile setback from the ordinary high water mark.
h. Alaktak River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
i. Chipp River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
j. Oumalik River: a 0.5-mile setback from the Oumalik River ordinary high water mark from the mouth</td></tr>
</table>

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

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<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>only apply to the east bank where the Ikpikpuk River is the [Northeast NPR-A] planning area boundary.
c. Miguakiak River: a 0.5-mile setback from the bank’s highest high watermark.
d. Kikiakrorak and Kogosukruk Rivers: Note: The following discussion refers only to portions of the Kikiakrorak River downstream from T2N, R4W, U.M., and the Kogosukruk River (including the four tributaries off the southern bank) downstream from T2N, R3W, U.M. No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 1 mile of the top of the bluff (or bank if there is no bluff) on either side of the rivers and several of the Kogosukruk tributaries.
e. Fish Creek: No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 3 miles (from the bank’s highest high watermark) of the creek downstream from the eastern edge of section 31, T11N, R1E, U.M. or within 0.5 mile (from the bank’s highest high watermark) of the creek farther upstream.
f. Judy Creek: a 0.5-mile setback from the banks’ highest high watermark extending from the mouth to the confluence of an unnamed tributary in section 8, T8N, R2W, U.M.
g. Tingmiaksiqvik River: No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 0.5 mile (from the bank’s highest high water mark) of this river from its headwaters within section 13, T7N, R1W, U.M. downstream to its confluence with Fish Creek.

Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the stream bed and adjacent to the rivers listed below at the distances identified. These setbacks are measured from the centerline of the river as determined by the current hydrology at the time of application. The standard setback is 0.5 mile and increased to 0.75 mile where subsistence cabins and campsites are numerous. Along the Colville River and a portion of the Ikpikpuk a 1-mile setback is required to protect important raptor habitat. (For locations along rivers where setback distances change, see Map 20 in the Final Northwest National Petroleum Reserve-
Alaska Integrated Activity Plan/Environmental Impact Statement). On a case-by case basis, and in consultation with</td><td colspan="4">upstream to section 5, T8N, R14W, U.M., and a 0.5-mile setback in and above section 5, T8N, R14W, U.M.
k. Titaluk River: a 0.5-mile setback from the centerline. In Alternatives B-1 and B-2, the setback would be 2 miles from the centerline from its confluence with the Ikpikpuk River upstream through T7N, R12W, U.M.; above that point the setback would be the same as described above.
l. Kigalik River: a 0.5-mile setback from the ordinary high water mark.
m. Maybe Creek: a 0.5-mile setback from the ordinary high water mark.
Topagoruk River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
o. Ishuktak Creek: a 0.5-mile setback from the ordinary high water mark.
p. Meade River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark on BLM-managed lands.
Usuktuk River: a 0.5-mile setback (1 mile for Alternative B-2) from the ordinary high water mark on BLM-managed lands.
r. Pikroka Creek: a 0.5-mile setback from the ordinary high water mark.
s. Nigisaktuvik River: a 0.5-mile (1 mile for Alternative B-2) setback from the Nigisakturik River ordinary high water mark upstream from the confluence with the Meade River to section 1, T11N, R25W, U.M. and a 0.5-mile setback further upstream.
t. Inaru River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
u. Kucheak Creek: a 0.5-mile setback from the ordinary high water mark.
v. Avalik River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
w. Niklavik Creek: a 0.5-mile setback from the ordinary high water mark.
x. Kugrua River: a 0.5-mile setback from the ordinary high water mark.
y. Kungok River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark on BLM-managed lands.
z. Kolipsun Creek: a 0.5-mile setback from the ordinary high water mark upstream through T13N, R28W, U.M.
aa. Maguriak Creek: a 0.5-mile setback from the ordinary high water mark upstream through T12N, R29W, U.M.
ab. Mikigealiak River: a 0.5-mile setback from the ordinary high water mark upstream through T12N, R30W, U.M.
ac. Kuk River: a 0.5-mile setback (1 mile for Alternative B-2) from the ordinary high water mark on BLM-managed lands.
ad. Ketik River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
ae. Kaolak River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
af. Ivisaruk River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
ag. Nokotlek River: a 0.5-mile setback from the ordinary high water mark.
ah. Ongorakvik River: a 0.5-mile setback from the ordinary high water mark.
ai. Tunalik River: a 0.5-mile setback from the ordinary high water mark.
aj. Avak River: a 0.5-mile setback from the ordinary high water mark within the NPR-A.</td></tr>
</table>

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings perpendicular to the main channel will be permitted (unless noted otherwise) through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event.
a. Colville River: a 1-mile setback from the northern bluff (or bank if there is no bluff) of the Colville River extending the length of that portion of the river within the [Northwest NPR-A] Planning Area. Road crossings intended to solely support oil and gas activities are prohibited. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within NPR-A.
b. Ikpikpuk River: a 0.75-mile setback from the centerline of the Ikpikpuk River extending from the mouth south to section 19, T7N, R11W, U.M. From section 19, T7N, R11W, U.M. to section 4, T3N, R12W, U.M., a 1-mile setback is required. Beginning at section 4, T3N, R12W, U.M., a 0.5-mile setback will be required to the confluence of the Kigalik River and Maybe Creek.
c. Alaktak River: a 0.75-mile setback from the centerline of the Alaktak River extending from the mouth to the Ikpikpuk River.
d. Chipp River: a 0.75-mile setback from the centerline of the Chipp River extending from the mouth to the Ikpikpuk River.
e. Oumalik River: a 0.75-mile setback from the centerline of the Oumalik River from the mouth upstream to section 5, T8N, R14W, U.M., and a 0.5-mile setback from section 5, T8N, R14W, U.M., upstream to section 2, T5N, R15W, U.M.
f. Titaluk River: a 0.5-mile setback from the centerline of the Titaluk River from the confluence with the Ikpikpuk River upstream to section 1, T2N, R22W, U.M.
g. Kigalik River: a 0.5-mile setback from the centerline of the Kigalik River from the confluence with the Ikpikpuk River upstream to the [Northwest NPR-A] Planning area boundary.
h. Maybe Creek: a 0.5-mile setback from the centerline of the Maybe Creek from the confluence with the Ikpikpuk River upstream to section 8, T2S R6W, U.M.
i. Topagoruk River: a 0.75-mile setback from the centerline of</td><td colspan="4">ak. Nigu River: a 0.5-mile setback from the ordinary high water mark from the confluence with the Etivluk River upstream to the boundary of NPR-A
al. Etivluk River: a 0.5-mile setback from the ordinary high water mark.
am. Ipnavik River: a 0.5-mile setback from the ordinary high water mark.
an. Kuna River: a 0.5-mile setback from the ordinary high water mark.
ao. Kiligwa River: a 0.5-mile setback from the ordinary high water mark.
ap. Nuka River: a 0.5-mile setback from the ordinary high water mark.
aq. Driftwood Creek: a 0.5-mile setback from the ordinary high water mark.
ar. Utukok River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark within the NPR-A.
as. Awuna River: a 0.5-mile setback from the ordinary high water mark.
at. Carbon Creek: a 0.5-mile setback from the ordinary high water mark.
au. Kokolik River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark within the NPR-A.
av. (Alternative B-2 only) Keolok Creek: a 0.5-mile setback from the ordinary high water mark.</td></tr>
</table>

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
the Topagoruk River from the mouth upstream to the confluence with Ishuktak Creek. A 0.5-mile setback from each bank upstream from the confluence with the Ishuktak to section 3, T7N, R17W, U.M. j. Ishuktak Creek: a ½-mile setback from the centerline of Ishuktak Creek from the confluence with the Topagoruk River to Sec. 24, T8N, R16W, UM. k. Meade River: a 0.75-mile setback from the centerline of the Meade River upstream to section 6, T6N, R21W, U.M. A 0.5-mile setback from each bank upstream from section 6, T6N, R21W, U.M. to the [Northwest NPR-A] Planning area boundary. l. Usuktuk River: a 0.75-mile setback from the centerline of the Usuktuk River upstream from the confluence with the Meade River to section 36, T10N, R19W, U.M. m. Pikroka Creek a 0.75-mile setback from the centerline of the Pikroka Creek upstream from the confluence with the Meade River to section 11, T8N, R23W, U.M. n. Nigisaktuvik River: a 0.75-mile setback from the centerline of the Nigisaktuvik River upstream from the confluence with the Meade River to section 1, T11N, R25W, U.M. o. Inaru River: a 0.75-mile setback from the centerline. [**Note:** the Northwest NPR-A plan incorrectly indicated that the Inaru River extended upstream to section 17, T15N, R25W, U.M.] p. Kucheak Creek: a 0.75-mile setback from the centerline of Kucheak Creek from the confluence with the Inaru River upstream to section 20, T13N, R24W, U.M. q. Avalik River: a 0.5-mile setback from the centerline of the Avalik River along that portion of the river within the [Northwest NPR-A] Planning area. r. Niklavik Creek: a 0.5-mile setback from the centerline of the Niklavik Creek from the confluence with the Inaru River upstream to section 5, T17N, R21W, U.M.				
Colville River Special Area Management Plan-Protection 1 <u>Objective</u>: Minimize the loss of arctic peregrine falcon nesting habitat in the Colville River Special Area. <u>Requirement/Standard</u>: To minimize the direct loss of arctic peregrine falcon nesting habitat and to protect nest sites in the Colville River Special Area the following protective measures apply: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the stream bed and adjacent to the rivers listed below at the distances identified. On a	*(Colville River Special Area Management Plan Protection 1 would not be changed as part of this plan, except that under Alternatives B-1 and B-2, the setbacks for the Colville, Kikiarorak, and Kogosukruk rivers is widened to 2 miles.)*			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>case-by-case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate; based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings perpendicular to the main channel will be permitted through setback areas.
a. Colville River: downstream of the Etivluk River a continuous 1-mile setback measured from the highest high watermark on the left bank (facing downstream); upstream of the Etivluk River a 1-mile setback measured from the ordinary high watermark of the bank on both sides of the river. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes.
b. Kikiarorak River: downstream from T2N, R4W, U.M., a continuous 1-mile setback as measured from the top of the bluff (or bank if there is no bluff) of both sides of the river.
c. Kogosukruk River: downstream from T2N, R3W, U.M., a continuous 1-mile setback as measured from the top of the bluff (or bank if there is no bluff) of both sides of the river and several of its tributaries.</td><td colspan="4"></td></tr>
<tr><td>K-2 Lease Stipulation--Deep Water Lakes
Northeast
<u>Objective</u>: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing, or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities.
<u>Requirement/Standard</u>: Generally, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within 0.25 mile of the ordinary high watermark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet [4 meters]; Mellor 1985). On a case-by-case basis in consultation with federal, State and North Slope Borough regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline(s), road crossings, and other permanent facilities may be considered through the permitting</td><td colspan="4">K-2 Lease Stipulation/Best Management Practice – Deep Water Lakes
Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternatives, K-2 would be a best management practice.
<u>Objective</u>: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities.
<u>Requirement/Standard</u>: Generally, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within 0.25 mile of the ordinary high watermark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet [4 meters]; Mellor 1985). On a case-by-case basis in consultation with federal, State and North Slope Borough regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline(s), road crossings, and other permanent facilities may be considered through the permitting process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal.</td></tr>
</table>

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal and if it is determined that there is no feasible or prudent alternative. **Northwest** Objective: Same. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within 0.25 mile of the ordinary high watermark of any deep lake as determined to be in lake zone III, i.e., depth >4 meters (Mellor 1985). On a case-by-case basis, and in consultation with federal, State and North Slope Borough regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline, road crossings, and other permanent facilities may be permitted through or in these areas where the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative.				
K-3a[4] Stipulation - Teshekpuk Lake Shoreline **Northeast** (**Note**: Teshekpuk Lake and islands within the lake (approximately 219,000 acres) will not be available for oil and gas leasing.) Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of this large and regionally significant deep water lake; the loss of cultural and paleontological resources; impacts to subsistence cabins, campsites and associated activities; and to protect fish and wildlife habitat including important insect-relief areas. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited within 0.25 mile of the ordinary high watermark of Teshekpuk Lake. In addition, no permanent oil and gas facilities, except pipelines, would be allowed in portions of T14−15N, R9W, and T15N, R8W, U.M. greater than 0.25 mile of the ordinary high watermark of Teshekpuk Lake as depicted on Map 2-1. (No alternative procedures will be approved.)	***K-3a Stipulation – Teshekpuk Lake Shoreline*** **NOTE: this applies only to Alternative C.** Alternatives B-1 and B-2 have no comparable provision because no non-subsistence permanent infrastructure would be allowed within the Teshekpuk Lake shoreline area. Alternative D also has no comparable provision, but note that Teshekpuk Lake is a deep water lake to which Stipulation K-2 applies. Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of this large and regionally significant deep water lake; the loss of cultural and paleontological resources; impacts to subsistence cabins, campsites and associated activities; and to protect fish and wildlife habitat including important insect-relief areas. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited within 0.25 mile of the ordinary high watermark of Teshekpuk Lake. In addition, no permanent oil and gas facilities, except pipelines, will be allowed in portions of T14−15 N, R9W, and T15N, R8W, U.M. greater than 0.25 mile of the ordinary high watermark of Teshekpuk Lake as depicted on Map 2-3K. (No waiver, exception, or modification will be approved.)			

[4] K-3a, K-4a, K-5a, and K-8a all refer to Stipulations K-3, K-4, K-5, and K-8 in the Northeast NPR-A IAP ROD. K-3b, K-4b, K-5b, and K-8b refer to K-3, K-4, K-5, and K-8 in the Northwest NPR-A IAP/ROD.

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr>
<td>K-3b Lease Stipulation–Dease Inlet, Admiralty Bay, Elson Lagoon, and Associated Barrier Islands
Northwest
Lease stipulations for Dease Inlet, Admiralty Bay, Elson Lagoon, and the Barrier Islands, contain specific criteria that have been incorporated into stipulation language. Because of sensitive biological resources and/or subsistence concerns of Dease Inlet, Admiralty Bay, Elson Lagoon, and inland of the Barrier Islands, the standard(s) for exploration and development activities are set high with the burden of proof resting with the lessee to demonstrate to the authorized officer that granting an approval is warranted.
<u>Objective</u>: Protect fish and wildlife habitat, preserve air and water quality, and minimize impacts to traditional subsistence activities and historic travel routes on Dease Inlet, Admiralty Bay, and Elson Lagoon.
<u>Requirement/Standard (Exploration)</u>: Oil and gas exploration operations (e.g., drilling, seismic exploration, and testing) are not allowed on Dease Inlet, Admiralty Bay, and Elson Lagoon (including natural and barrier islands), between May 15 and October 15 of each season. Requests for approval of any activities must be submitted in advance and must be accompanied by evidence and documentation that demonstrates to the satisfaction of the authorized office that the actions or activities meet all of the following criteria:
a. Exploration activities will not unreasonably conflict with traditional subsistence uses or significantly impact seasonally concentrated fish and wildlife resources.
b. There is adequate spill response capability to effectively respond during periods of broken ice and/or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include improvements in blowout prevention technology, equipment and/or changes in operational procedures and "top-setting" of hydrocarbon-bearing zones.
c. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic will be conducted to minimize additional impacts or further compounding of “direct spill” related impacts on area resources and subsistence uses.
d. The location of exploration and related activities shall be sited</td>
<td colspan="3">K-3b Lease Stipulation/Best Management Practice – Kogru River, Dease Inlet, Admiralty Bay, Elson Lagoon, Peard Bay, Wainwright Inlet/Kuk River, and Kasegaluk Lagoon, and their associated Islands
Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-3b would be a best management practice. Alternatives B-1 and C, and, to a lesser extent, Alternative B-2, would generally prohibit non-subsistence permanent infrastructure in these waters.
<u>Objective</u>: Protect fish and wildlife habitat (including, but not limited to, that for waterfowl and shorebirds, caribou insect-relief, and marine mammals), preserve air and water quality, and minimize impacts to subsistence activities and historic travel routes on the major coastal waterbodies.
<u>Requirement/Standard (Exploration)</u>: Oil and gas exploration operations (e.g., drilling, seismic exploration, and testing) are not allowed on the major coastal waterbodies and coastal islands between May 15 and October 15 of each season. Requests for approval of any activities must be submitted in advance and must be accompanied by evidence and documentation that demonstrates to the satisfaction of the authorized office that the actions or activities meet all of the following criteria:
a. Exploration activities will not unreasonably conflict with subsistence uses or significantly impact seasonally concentrated fish and wildlife resources.
b. There is adequate spill response capability to effectively respond during periods of broken ice and/or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include improvements in blowout prevention technology, equipment and/or changes in operational procedures and “top-setting” of hydrocarbon-bearing zones.
c. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic will be conducted to minimize additional impacts or further compounding of “direct spill” related impacts on area resources and subsistence uses.
d. The location of exploration and related activities shall be sited so as to not</td>
<td>No comparable provision.</td>
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ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
so as to not pose a hazard to navigation by the public using high-use traditional subsistence-related travel routes into and through Dease Inlet, Admiralty Bay and Elson Lagoon, as identified by the North Slope Borough, recognizing that marine and nearshore travel routes change over time, subject to shifting environmental conditions.	pose a hazard to navigation by the public using high-use subsistence-related travel routes into and through the major coastal waterbodies, as identified by the North Slope Borough, recognizing that marine and nearshore travel routes change over time, subject to shifting environmental conditions.			
e. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.	e. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.			
<u>Requirement/Standard (Development)</u>: With the exception of linear features such as pipelines, no permanent oil and gas facilities are permitted on or under the water within 0.75 mile seaward of the shoreline (as measured from mean high tide) of Dease Inlet, Admiralty Bay, and Elson Lagoon or the natural islands (excluding Barrier Islands). Elsewhere, permanent facilities within Dease Inlet, Admiralty Bay, and Elson Lagoon will only be permitted on or under the water if they can meet all the following criteria:	<u>Requirement/Standard (Development)</u>: With the exception of linear features such as pipelines, no permanent oil and gas facilities are permitted on or under the water within 0.75 mile seaward of the shoreline (as measured from mean high tide) of the major coastal waterbodies or the natural coastal islands (to the extent that the seaward subsurface is within NPR-A). Elsewhere, permanent facilities within the major coastal waterbodies will only be permitted on or under the water if they can meet all the following criteria:			
f. Design and construction of facilities shall minimize impacts to traditional subsistence uses, travel corridors, seasonally concentrated fish and wildlife resources.	f. Design and construction of facilities shall minimize impacts to subsistence uses, travel corridors, seasonally concentrated fish and wildlife resources.			
g. Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to traditional subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.	g. Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.			
h. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through Dease Inlet, Admiralty Bay and Elson Lagoon as identified by the North Slope Borough.	h. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through the major coastal waterbodies as identified by the North Slope Borough.			
i. Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment	i. Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment and/or changes in operational procedures, and “top-setting” of hydrocarbon-bearing zones.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
and/or changes in operational procedures, and "top-setting" of hydrocarbon-bearing zones. j. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound "direct spill" related impacts on area resources and subsistence uses. k. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.	j. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound "direct spill" related impacts on area resources and subsistence uses. k. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.			
K-4a Lease Stipulation - Goose Molting Area **Northeast** Objective: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area. Requirement/Standard (General): Within the Goose Molting Area no permanent oil and gas facilities, except for pipelines will be allowed on the approximately 240,000 acres of lake buffers illustrated in lavender on Map 2-1. No alternative procedures will be considered. Prior to the permitting of a pipeline in the Goose Molting Area, a workshop will be convened to determine the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. In addition, only "in field" roads will be authorized as part of oil and gas field development. Requirement/Standard (Exploration): In goose molting habitat area exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, and ice airstrips, unless the lessee demonstrates that construction of permanent facilities (outside the identified Goose Molting Restricted Surface Occupancy Areas) such as gravel airstrips, storage pads, and connecting roads is environmentally preferable (Also see *Stipulation K-11* regarding allowable surface disturbance). In addition, the following standards will be followed for permitted activities: a. From June 15 through August 20 exploratory drilling and associated activities are prohibited. The intent of this rule is to restrict exploration drilling during the period when geese are present. b. Water extraction from any lake used by molting geese shall not	***K-4a Lease Stipulation/Best Management Practice – Goose Molting Area*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing, K-4a would be a best management practice. Objective: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area. Requirement/Standard (General): Within the Goose Molting Area no permanent oil and gas facilities, except for pipelines, will be allowed within 1 mile of the shoreline of goose molting lakes. (See Map 2-3K for the current location of these 1-mile setback areas.) No waiver, exception, or modification will be considered. Prior to the permitting of a pipeline in the Goose Molting Area, a workshop will be convened to determine the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to Federal, state, and North Slope Borough representatives. In addition, only "in field" roads will be authorized as part of oil and gas field development. Requirement/Standard (Exploration): In goose molting habitat area exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, and ice airstrips, unless the lessee demonstrates that construction of permanent facilities (outside the identified Goose Molting Restricted Surface Occupancy Areas) such as gravel airstrips, storage pads, and connecting roads is environmentally preferable. (Also see *Stipulation K-11* regarding allowable surface disturbance). In addition, the following standards will be followed for permitted activities: a. From June 15 through August 20 exploratory drilling and associated activities are prohibited. The intent of this rule is to restrict exploration drilling during the period when geese are present. b. Water extraction from any lake used by molting geese shall not alter			***K-4a Lease Stipulation – Goose Molting Area*** Objective: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area. Requirement/ Standard: Roads will be designed to minimize impacts to molting geese. In general, roads shall be designed to avoid areas within 0.25 mile of molting geese lakes.

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.	hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.			
c. Oil and gas exploration activities will avoid alteration (e.g., damage or disturbance of soils, vegetation, or surface hydrology) of critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss), as identified by the authorized officer in consultation with the USFWS.	c. Oil and gas exploration activities will avoid alteration (e.g., damage or disturbance of soils, vegetation, or surface hydrology) of critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss), as identified by the authorized officer in consultation with the USFWS.			
Requirement/Standard (Development): In Goose Molting Area, the following standards will be followed for permitted activities:	Requirement/Standard (Development): In the Goose Molting Area, the following standards will be followed for permitted activities:			
a. Within the Goose Molting Area from June 15 through August 20, all off-pad activities and major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended (see also Lease Stipulation K-5-d), unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb molting geese during the period when geese are present.	a. Within the Goose Molting Area from June 15 through August 20, all off-pad activities and major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended (see also Lease Stipulation K-5-d), unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb molting geese during the period when geese are present.			
b. Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.	b. Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.			
c. Oil and gas activities will avoid altering (i.e., damage or disturbance of soils, vegetation, or surface hydrology) critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss) and salt marsh habitats.	c. Oil and gas activities will avoid altering (i.e., damage or disturbance of soils, vegetation, or surface hydrology) critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss) and salt marsh habitats.			
d. Permanent oil and gas facilities (including gravel roads, pads, and airstrips, but excluding pipelines) and material sites will be sited outside the identified buffers and restricted surface occupancy areas. Additional limits on development footprint apply; (also see Lease Stipulation K-11.)	d. Permanent oil and gas facilities (including gravel roads, pads, and airstrips, but excluding pipelines) and material sites will be sited outside the identified buffers and restricted surface occupancy areas. Additional limits on development footprint apply; (also see Lease Stipulation K-11.)			
e. Between June 15 and August, 20 within the Goose Molting Area, oil and gas facilities shall incorporate features (e.g., temporary fences, siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by the authorized officer in consultation with appropriate federal, State, and North Slope Borough regulatory	e. Between June 15 and August, 20 within the Goose Molting Area, oil and gas facilities shall incorporate features (e.g., temporary fences, siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by the authorized officer in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>and resource agencies.
f. Strategies to minimize ground traffic shall be implemented from June 15 through August 20. These strategies may include limiting trips, use of convoys, different vehicle types, etc. to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.</td><td colspan="3">f. Strategies to minimize ground traffic shall be implemented from June 15 through August 20. These strategies may include limiting trips, use of convoys, different vehicle types, etc. to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.</td><td></td></tr>
<tr><td>g. Within the Goose Molting Area aircraft use (including fixed wing and helicopter) shall be restricted from June 15 through August 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include: (1) limiting flights to two round-trips/week, and (2) limiting flights to corridors established by the BLM after discussions with appropriate federal, State, and North Slope Borough regulatory and resource agencies. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. Note: This site-specific lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and required operating procedures. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.</td><td colspan="3">g. Within the Goose Molting Area aircraft use (including fixed wing and helicopter) shall be restricted from June 15 through August 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include: (1) limiting flights to two round-trips/week, and (2) limiting flights to corridors established by the BLM after discussions with appropriate federal, State, and North Slope Borough regulatory and resource agencies. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. Note: This site-specific lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.</td><td></td></tr>
<tr><td>h. Any permit for development issued under this IAP/EIS will include a requirement for the lessee to conduct monitoring studies necessary to adequately determine consequences of development and any need for change to mitigations. Monitoring studies will be site- and development-specific within a set of over-arching guidelines developed by the BLM after conferring with appropriate federal, State, North Slope Borough agencies. The study(s) will include the construction period and will continue for a minimum of 3 years after construction has been completed and production has begun. The monitoring studies will be a continuation of evaluating the effectiveness of the K-4 Lease Stipulation requirements in meeting the objective of K-4 and determine if any changes to the lease stipulation or any project specific mitigation(s) are</td><td colspan="3">h. Any permit for development issued under this IAP/EIS will include a requirement for the lessee to conduct monitoring studies necessary to adequately determine consequences of development and any need for change to mitigations. Monitoring studies will be site- and development-specific within a set of over-arching guidelines developed by the BLM after conferring with appropriate federal, State, North Slope Borough agencies. The study(ies) will include the construction period and will continue for a minimum of 3 years after construction has been completed and production has begun. The monitoring studies will be a continuation of evaluating the effectiveness of Stipulation K-4a's requirements in meeting the objective of K-4 and determine if any changes to the lease stipulation or any project specific mitigation(s) are necessary. If changes are determined to be necessary, the BLM, with the lessee and/or their representative, will conduct an assessment of the feasibility of altering development operation (e.g., reduced human activity, visibility barriers,</td><td></td></tr>
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ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
necessary. If changes are determined to be necessary, the BLM, with the lessee and/or their representative, will conduct an assessment of the feasibility of altering development operation (e.g., reduced human activity, visibility barriers, noise abatement). Any changes determined necessary will be implemented prior to authorization of any new construction.	noise abatement). Any changes determined necessary will be implemented prior to authorization of any new construction.			
K-4b Required Operating Procedure – Brant Survey Area **Northwest** Objective: Minimize the loss or alteration of habitat for, or disturbance of, nesting and brood rearing brant in the Brant Survey Area. Requirement/Standard: a. Aerial surveys for brant nesting colonies and brood-rearing areas shall be conducted for a minimum of 2 years before authorization of construction of permanent facilities. At a minimum, the survey area shall include the proposed development site(s) (i.e., the footprint) and the surrounding 0.5-mile area. These surveys shall be conducted following accepted BLM protocol. b. Development may be prohibited or activities curtailed within 0.5 mile of all identified brant nesting colonies and brood-rearing areas identified during the 2-year survey.	***K-4b Best Management Practice – Brant Survey Area*** Objective: Minimize the loss or alteration of habitat for, or disturbance of, nesting and brood rearing brant in the Brant Survey Area. Requirement/Standard: a. Aerial surveys for brant nesting colonies and brood-rearing areas shall be conducted for a minimum of 2 years before authorization of construction of permanent facilities. At a minimum, the survey area shall include the proposed development site(s) (i.e., the footprint) and the surrounding 0.5-mile area. These surveys shall be conducted following accepted BLM protocol. b. Development may be prohibited or activities curtailed within 0.5 mile of all identified brant nesting colonies and brood-rearing areas identified during the 2-year survey. *(Same text as in Northwest NPR-A 2004 Record of Decision)*			
K-5a Lease Stipulation - Teshekpuk Lake Caribou Habitat Area **Northeast** Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration. Requirement/Standard: In the Teshekpuk Lake Caribou Habitat Area the following standards will be applied to permitted activities: a. Before authorization of construction of permanent facilities (limited as they may be by restricted surface occupancy areas established in other lease stipulations), the lessee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the Teshekpuk Caribou Herd has been completed within the last 10 years. The study shall include a minimum of 4 years of current data on the Teshekpuk Caribou Herd movements and the study design shall be approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough wildlife	***K-5a Lease Stipulation/Best Management Practice –Teshekpuk Lake Caribou Habitat Area*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-5a would be a best management practice. Under Alternatives B-1, B-2 and C the Teshekpuk Lake Caribou Habitat Area encompasses those lands designated as such in the Northeast NPR-A Supplemental IAP Record of Decision and the Caribou Study Area in the Northwest NPR-A IAP Record of Decision as well as additional lands south of the area as defined in Alternative A. Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration. Requirement/Standard: In the Teshekpuk Lake Caribou Habitat Area the following standards will be applied to permitted activities: a. Before authorization of construction of permanent facilities (limited as they may be by restricted surface occupancy areas established in other lease stipulations), the lessee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the Teshekpuk			***K-5a Lease Stipulation– Teshekpuk Lake Caribou Habitat Area*** Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area (see Map 2-4K) that are essential for all season use, including calving and rearing, insect-relief, and migration. Requirement/

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>and resource agencies. The study should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Teshekpuk Lake Caribou Habitat Area. Study data may be gathered concurrently with other activities as approved by the authorized officer and in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the Teshekpuk Lake Caribou Habitat Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the Teshekpuk Caribou Herd) and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the Teshekpuk Lake Caribou Habitat Area during all seasons.
b. Within the Teshekpuk Lake Caribou Habitat Area, lessees shall orient linear corridors when laying out oil field developments to the extent practicable, to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities.
c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the authorized officer, after consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement.
d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving and insect-relief periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The lessee shall submit with the development proposal a “stop work” plan that considers this and any other mitigation related to caribou</td><td colspan="3">Caribou Herd has been completed within the last 10 years. The study shall include a minimum of four years of current data on the Teshekpuk Caribou Herd movements and the study design shall be approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. The study should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Teshekpuk Lake Caribou Habitat Area. Study data may be gathered concurrently with other activities as approved by the authorized officer and in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the Teshekpuk Lake Caribou Habitat Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the Teshekpuk Caribou Herd) and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the Teshekpuk Lake Caribou Habitat Area during all seasons.
b. Within the Teshekpuk Lake Caribou Habitat Area, lessees shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities.
c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the authorized officer, after consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement.
d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving and insect-relief periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The lessee shall submit with the development proposal a “stop work” plan that considers this and any other mitigation related to caribou early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.</td><td><u>Standard</u>: Same as Alternatives B-1 through C.</td></tr>
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<td>early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.
e. The following ground and air traffic restrictions shall apply to permanent oil and gas-related roads in the areas and time periods indicated:
1. Within the Teshekpuk Lake Caribou Habitat Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
2. The lessee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted crossing by a large number of caribou appears to be imminent. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter by authorized users of the [Northeast NPR-A] planning area, including oil and gas lessees, from May 20 through August 20 within the Teshekpuk Lake Caribou Habitat Area, except for emergency purposes. The lessee shall submit with</td>
<td colspan="3">e. The following ground and air traffic restrictions shall apply in the areas and time periods indicated. Ground traffic restrictions apply to permanent oil and gas-related roads:
1. Within the Teshekpuk Lake Caribou Habitat Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
2. The lessee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped:
a. temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted crossing by a large number of caribou appears to be imminent. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation.
b. by direction of the authorized officer throughout a defined area for up to four weeks to prevent displacement of calving caribou.
The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20 unless doing so endangers human life or violates safe flying practices. Authorized users of the NPR-A may be restricted from using aircraft larger than a Twin Otter, and limited to an average of one fixed-wing aircraft takeoff and landing per day per airstrip, except for emergency purposes. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter by authorized users of the NPR-A, including oil and gas lessees, from</td>
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<tr><td>the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and required operating procedures. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.
5. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through June 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include limiting fixed-wing aircraft takeoffs and landings by authorized users of the [Northeast NPR-A] planning area to an average of one round-trip flight per day from May 20 through June 20, at aircraft facilities within the Teshekpuk Lake Caribou Habitat Areas. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
6. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be defined annually by the authorized officer in consultation with the Alaska Department of Fish and Game. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and required operating procedures. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.</td><td colspan="3">May 20 through August 20 within the Teshekpuk Lake Caribou Habitat Area, except for emergency purposes. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.
5. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be defined annually by the authorized officer in consultation with the Alaska Department of Fish and Game. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.</td><td></td></tr>
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<tr><td>K-5b Required Operating Procedure – Caribou Study Area
Northwest
<u>Objective</u>: None stated.
<u>Requirement/Standard</u>: Before authorization of construction of permanent facilities, the lessee shall design and implement a study of caribou movement, especially during the insect season. The study would include a minimum of 3 years of current data on caribou movements. The study design shall be approved by the authorized officer and should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Caribou Study Area. Study data may be gathered concurrently with other activities.</td><td colspan="4">K-5b Best Management Practice – Caribou Study Area
NOTE: This applies only to Alternative D. Alternatives B1-, B-2, and C are incorporated into K-5a Stipulation, above.
<u>Objective</u>: Minimize disturbance and hindrance of caribou, or alteration of caribou movements in the Caribou Study Area.
<u>Requirement/ Standard</u>: Before authorization of construction of permanent facilities, the lessee shall design and implement a study of caribou movement, especially during the insect season. The study would include a minimum of 3 years of current data on caribou movements. The study design shall be approved by the authorized officer and should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Caribou Study Area. Study data may be gathered concurrently with other activities.</td></tr>
<tr><td>K-6 Stipulation - Coastal Area
Northeast
<u>Objective</u>: Minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; to prevent contamination of marine waters; loss of important bird habitat; alteration or disturbance of shoreline marshes; and impacts to subsistence resources activities.
<u>Requirement/Standard</u>: In the Coastal Area, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least 0.75 mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within 0.75 mile inland of the coastline, the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning-Line sites, shall be considered. Use of existing sites within 0.75 mile of the coastline shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Captains' Association, and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.</td><td colspan="4">K-6 Lease Stipulation – Coastal Area (Alternatives B-1, C, and D)
Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-6 would be a best management practice.
<u>Objective</u>: Minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; to protect the summer shoreline habitat for polar bears, walrus, and seals; to prevent contamination of marine waters; loss of important bird habitat; alteration or disturbance of shoreline marshes; and impacts to subsistence resources activities.
<u>Requirement/Standard</u>: No permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located in the Coastal Area, which includes all barrier and offshore islands within NPR-A and a coastal strip extending 0.75 mile inland from the coast. (In Alternatives B-1 and C, the coastal strip between the Kogru River and Tangent Point would extend 1 mile inland, instead of 0.75 mile, in order to protect molting geese habitat.) Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within 0.75 mile inland of the coastline (Alternatives B-1 and C, 1 mile inland between Kogru River and Tangent Point), the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning-Line sites, shall be considered. Use of existing sites within 0.75 mile of the coastline (Alternatives B-1 and C, 1 mile inland between Kogru River and Tangent Point) shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Captains' Association, and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. In a case in which the BLM authorizes a permanent oil and gas facility within the Coastal Area, the lessee/permittee shall develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.</td></tr>
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<tr><td>Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: In the Coastal Area, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least 0.75 mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within 0.75 mile inland of the coastline, the practicality of locating the facility at previously occupied sites, such as the former Cape Simpson, Peard Bay, or Wainwright Distant Early Warning-Line sites, shall be considered. Use of existing sites within 0.75 mile of the coastline shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users.</td><td colspan="4">K-6 Lease Stipulation – Coastal Area (Alternative B-2 only)
<u>Objective</u>: Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources activities.
<u>Requirement/Standard</u>:
a. Exploratory well drill pads, production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the Reserve and the mainland, or in inland areas within one mile of the coast. (Note: This would include the entirety the Kasegaluk Lagoon and Peard Bay Special Areas.) Other facilities necessary for oil and gas production within NPR-A that necessarily must be within this area (e.g., barge landing, seawater treatment plant, or spill response staging and storage areas) would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. Lessees/permittees shall consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the North Slope Borough, and local whaling captains associations to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. In a case in which the BLM authorizes a permanent oil and gas facility within the Coastal Area, the lessee/permittee shall develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
b. Marine vessels used as part of a BLM-authorized activity shall maintain a 1-mile buffer from the shore when transiting past an aggregation of seals (primarily spotted seals) using a terrestrial haulout unless doing so would endanger human life or violate safe boating practices. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast except when necessary for the safe operation of the vessel.
c. Marine vessels used as part of a BLM-authorized activity shall maintain a 0.5-mile buffer from shore when transiting past an aggregation of walrus using a terrestrial haulout.</td></tr>
</table>

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
K-7 Lease Stipulation - Colville River Special Area **Northeast** <u>Objective</u>: Prevent or minimize loss of raptor foraging habitat (also see Lease Stipulation K-1; Rivers Area). <u>Requirement/Standard for Facilities</u>: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Additionally, within 15 miles of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative. Of particular concern are ponds, lakes, wetlands, and riparian habitats. **Note:** On a case-by-case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through these areas where no other feasible or prudent options are available. ***K-7 Lease Stipulation - Colville River Special Area*** **Northwest** <u>Objective</u>: Prevent or minimize loss of raptor foraging habitat. <u>Requirement/Standard</u>: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Within 15 mile of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative. Of particular concern are ponds, lakes, wetlands, and riparian habitats. **Note:** On a case-by case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through these areas where no other options are available.	***K-7 Lease Stipulation – Colville River Special Area*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-7 would be a best management practice <u>Objective</u>: Prevent or minimize loss of raptor foraging habitat (also see Lease Stipulation K-1; Rivers Area). <u>Requirement/Standard for Facilities</u>: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Additionally, within 15 miles of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal. Of particular concern are ponds, lakes, wetlands, and riparian habitats. **Note:** On a case-by-case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through the Colville River Special Area where no other feasible or prudent options are available.			No comparable provision.
Colville River Special Area Management Plan-Protection 2 <u>Objective</u>: Prevent or minimize loss of arctic peregrine falcon foraging habitat in the Colville River Special Area. <u>Requirement/Standard</u>: To minimize the direct loss of arctic peregrine falcon foraging habitat in the Colville River Special Area the following measures apply: If necessary to construct permanent facilities within the Colville River Special Area, all	*(Colville River Special Area Management Plan Protection 2 would not be changed.)*			*(Colville River Special Area Management Plan Protection 2 is deleted.)*

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>reasonable and practicable efforts shall be made to locate permanent facilities as far from arctic peregrine falcon nests as feasible. Within 15 miles of arctic peregrine falcon nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative. Of particular concern are ponds, lakes, wetlands, and riparian habitats. Note: On a case-by-case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through these areas where no other feasible or prudent options are available.</td><td colspan="3"></td><td></td></tr>
<tr><td>K-8a Lease Stipulation - Pik Dunes
<u>Objective</u>: Retain unique qualities of the Pik Dunes, including geologic and scenic uniqueness, insect-relief habitat for caribou, and habitat for several uncommon plant species.
<u>Requirement/Standard</u>: Surface structures, except approximately perpendicular pipeline crossings and ice pads, are prohibited within the Pik Dunes.</td><td colspan="4">K-8a Lease Stipulation – Pik Dunes
Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-8a would be a best management practice.
<u>Objective</u>: Retain unique qualities of the Pik Dunes, including geologic and scenic uniqueness, insect-relief habitat for caribou, and habitat for several uncommon plant species.
<u>Requirement/Standard</u>: Surface structures, except approximately perpendicular pipeline crossings and ice pads, are prohibited within the Pik Dunes.

(Same text as in Northeast NPR-A 2008 Record of Decision)</td></tr>
<tr><td>K-8b Lease Stipulation–Kasegaluk Lagoon Special Area
<u>Objective</u>: Protect the habitat of the fish, waterfowl, and terrestrial and marine wildlife resources of Kasegaluk Lagoon, and protect traditional subsistence uses and public access to and through Kasegaluk Lagoon for current and future generations of North Slope residents.
<u>Requirement/Standard</u>: Within the Kasegaluk Lagoon Special Area, oil and gas leasing is approved subject to the decision to defer the implementation of oil and gas leasing in the “leasing deferral area.” When leasing is implemented, no permanent oil and gas facilities are permitted within the boundary of the Special Area. Geophysical (seismic) exploration is authorized subject to the terms and conditions provided in other applicable required operating procedures. No restrictions are imposed on traditional subsistence activities and access for subsistence purposes.</td><td colspan="4">K-8b Best Management Practice – Kasegaluk Lagoon Special Area
Note: This applies only to Alternatives B-1 and C. There would be no comparable provision for Alternatives B-2 and D.

This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-8b would be a best management practice
<u>Objective</u>: Protect the habitat of the fish, waterfowl, and terrestrial and marine wildlife resources of Kasegaluk Lagoon, and protect subsistence uses and public access to and through Kasegaluk Lagoon for current and future generations of North Slope residents.
<u>Requirement/Standard</u>: No permanent oil and gas surface facilities are permitted in the Kasegaluk Lagoon and an area one mile inland from the lagoon.</td></tr>
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ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>K-9 Lease Stipulation – Caribou Movement Corridor
Northeast
<u>Objective</u>: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake to approximately 6 miles eastward towards the Kogru Inlet [River] and the area adjacent to the northwest corner of Teshekpuk Lake.
<u>Requirement/Standard</u>: Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines, will be allowed on the approximately 60,500 (approximately 50,800 acres east of Teshekpuk Lake, and approximately 9,700 acres northwest of Teshekpuk Lake) illustrated on Map 2-1K. Prior to the permitting of a pipeline in the Caribou Movement Corridors, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. Note: In addition to the general lease stipulations and required operating procedures, site-specific lease stipulations, i.e., K-3, K-4, K-5, and K-11 will also apply.
Northwest
No comparable provision.</td><td colspan="3">K-9 Lease Stipulation/Best Management Practice – Teshekpuk Lake Caribou Movement Corridors
Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-9 would be a best management practice. Alternatives B-1 and B-2 would generally prohibit non-subsistence permanent infrastructure in all, or nearly all, of these areas.
<u>Objective</u>: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake eastward to the Kogru River and the area between Teshekpuk Lake and an unnamed lake in T16−17 N, R8 W, U.M.
<u>Requirement/Standard</u>: Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines or, in the case of Alternative B-2 only other infrastructure associated with offshore oil and gas exploration and production, will be allowed on the approximately 62,100 (approximately 50,800 acres east of Teshekpuk Lake, and approximately 11,300 acres northwest of Teshekpuk Lake) illustrated on Map 2-3K. Prior to the permitting of permanent oil and gas infrastructure in the Caribou Movement Corridors, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives.</td><td>No comparable provision.</td></tr>
<tr><td>K-10 Lease Stipulation – Southern Caribou Calving Area
Northeast
<u>Objective</u>: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief) in the area south/southeast of Teshekpuk Lake:
<u>Requirement/Standard</u>: Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines, would be allowed on the approximately 240,000 acres illustrated on Map 2-1K. Prior to the permitting of a pipeline in the Southern Caribou Calving Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. Note: In addition to the general stipulations and required operating procedures, site-specific Stipulations K-4, K-5, K-6, and K-11 would also apply.</td><td colspan="3">K-10 Lease Stipulation/Best Management Practice – Teshekpuk Lake Southern Caribou Calving Area
Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-10 would be a best management practice. Alternatives B-1 and B-2 would generally prohibit non-subsistence permanent infrastructure in all, or nearly all, of this area.
<u>Objective</u>: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief) in the area south/southeast of Teshekpuk Lake.
<u>Requirement/Standard</u>: Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines or, in the case of Alternative B-2 only other infrastructure associated with offshore oil and gas exploration and production, will be allowed on the approximately 240,000 acres illustrated on Map 2-3K. Prior to the permitting of permanent oil and gas infrastructure in the Southern Caribou Calving Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to</td><td>No comparable provision.</td></tr>
</table>

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
Northwest No comparable provision.	federal, State, and North Slope Borough representatives. **Note:** In addition to the general stipulations and best management practices, site-specific *Stipulations K-4, K-5, K-6, and K-11* would also apply.			
K-11 Lease Stipulation: Lease Tracts A-G **Northeast** Objective: To protect key surface resources and subsistence resources/activities resulting from permanent oil and gas development and associated activities. Requirement Standard: Permanent surface disturbance resulting from oil and gas activities is limited to 300 acres within the following described lease tracts (Map 2-1K); this does not include surface disturbance activities from pipeline construction. Existing gravel pads within these tracts would not count against the 300-acre limit. A pipeline will be considered after a workshop is convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. (No alternative procedures will be approved). (Acreages are based on GIS calculations and are approximate): A. Total Acreage: approximately 52,700: • 26,500 acres = Restricted surface occupancy for permanent oil and gas facilities excluding pipelines (the 23,350 acres includes 5,605 acres of overlap with the Coastal area restrictions). • 26,200 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures. The total new development footprint cannot exceed 300 acres (0.6% of total acreage). B. Total Acreage: approximately 55,000: • 38,200 acres = Restricted surface occupancy for permanent oil and gas facilities, excluding pipelines (the 33,478 acres includes 5,131 acres of overlap with the Coastal area restrictions). • 16,800 acres = Area open to development subject to general and site-specific lease stipulations and required operating procedures. The total new development footprint cannot exceed 300 acres (0.5% of total acreage).	No comparable provision. Under Alternatives B-1 and B-2, leasing is unavailable in the area covered by tracts A-G.		***K-11 Lease Stipulation – Lease Tracts A-G*** Objective: To protect key surface resources and subsistence resources/activities resulting from permanent oil and gas development and associated activities. Requirement Standard: Permanent surface disturbance resulting from oil and gas activities is limited to 300 acres within the following described lease tracts (Maps 2-3K and 2-4K); this does not include surface disturbance activities from pipeline construction. Existing gravel pads within these tracts would not count against the 300-acre limit. A pipeline will be considered for development of one or more of these tracts after a workshop is convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but need not be limited to Federal, state, and North Slope Borough representatives. (No alternative procedures will be approved). (Acreages are based on GIS calculations and are approximate): A. Total Acreage: approximately 52,700: The total new development footprint cannot exceed 300 acres (0.6% of total acreage). B. Total Acreage: approximately 55,000: The total new development footprint cannot exceed 300 acres (0.5% of total acreage). C. Total Acreage: approximately 46,100: The total new development footprint cannot exceed 300 acres (0.7% of total acreage). D. Total Acreage: approximately 54,500: The total new development footprint cannot exceed 300 acres (0.6% of total acreage). E. Total Acreage: approximately 56,500: The total new development footprint cannot	

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>C. Total Acreage: approximately 46,100:
• 32,500 acres = Restricted surface occupancy for permanent oil and gas facilities, excluding pipelines.
• 3,600 acres = Area open to development subject to general and site-specific lease stipulations and required operating procedures.
The total new development footprint cannot exceed 300 acres (0.7% of total acreage).
D. Total Acreage: approximately 54,500:
• 46,900 acres = Restricted surface occupancy for permanent oil and gas facilities excluding pipelines.
• 7,700 acres = Area open to development subject to general and site-specific lease stipulations and required operating procedures.
The total new development footprint cannot exceed 300 acres (0.6% of total acreage).
E. Total Acreage: approximately 56,500:
• 32,200 acres = Restricted surface occupancy for permanent oil and gas facilities, excluding pipelines.
• 24,300 acres = Area open to development subject to general and site-specific lease stipulations and required operating procedures.
The total new development footprint cannot exceed 300 acres (0.5% of total acreage).
F. Total Acreage: approximately 57,100:
• 43,200 acres = Restricted surface occupancy for permanent oil and gas facilities, excluding pipelines.
• 4,900 acres = Restricted area open to development subject to the results of 3-year study requirement to determine appropriate placement of permanent facility(s) (Map 2-1).
• 9,000 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.
The total new development footprint cannot exceed 300 acres (0.5% of total acreage).
G. Total Acreage: approximately 56,800:
• 48,700 acres = Restricted surface occupancy for permanent oil and gas facilities excluding pipelines.
• 300 acres = Restricted area open to development subject to the results of 3-year study requirement to determine appropriate placement of permanent facility(s) (Map 2-1K).
• 7,800 acres = Area open to development subject to general and site specific lease stipulations and required operating</td><td colspan="2"></td><td colspan="2">exceed 300 acres (0.5% of total acreage).
F. Total Acreage: approximately 57,100:
The total new development footprint cannot exceed 300 acres (0.5% of total acreage).
G. Total Acreage: approximately 56,800:
The total new development footprint cannot exceed 300 acres (0.5% of total acreage).</td></tr>
</table>

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
procedures. The total new development footprint cannot exceed 300 acres (0.5% of total acreage). **Northwest** No comparable provision.				
No comparable provision.	***K-12 Lease Stipulation/Best Management Practice – Western Arctic Herd Habitat Area*** **Note:** This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-12 would be a best management practice. In each of the alternatives, this stipulation applies to the configuration of the Utukok River Uplands Special Area proposed for the respective alternative. Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through the Utukok River Uplands Special Area that are essential for all season use, including calving and rearing, insect-relief, and migration. Requirement/Standard: In the Utukok River Uplands Special Area the following standards will be applied to permitted activities: a. Before authorization of construction of permanent facilities, the lessee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the Western Arctic Herd has been completed within the last 10 years. The study shall include a minimum of four years of current data on the Western Arctic Herd's movements and the study design shall be approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies and the Western Arctic Caribou Herd Working Group. The study should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Utukok River Uplands Special Area. Study data may be gathered concurrently with other activities as approved by the authorized officer and in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the Utukok River Uplands Special Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the Western Arctic Herd) and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the Utukok River Uplands Special Area during all seasons. b. Within the Utukok River Uplands Special Area, lessees shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities. c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the authorized officer, after consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, in the Utukok River Uplands Special Area where pipelines potentially impede caribou movement. d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline				

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td></td><td colspan="4">and pad construction, but not drilling from existing production pads) shall be suspended within Utukok River Uplands Special Area from May 20 through August 20, unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving and insect-relief periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The lessee shall submit with the development proposal a “stop work” plan that considers this and any other mitigation related to caribou early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.
e. The following ground and air traffic restrictions shall apply to permanent oil and gas-related roads in the areas and time periods indicated:
1. Within the Utukok River Uplands Special Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
2. The lessee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped:
a. Temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted crossing by a large number of caribou appears to be imminent. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation.
b. By direction of the authorized officer throughout a defined area for up to four weeks to prevent displacement of calving caribou.
The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Utukok River Uplands Special Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Within the Utukok River Uplands Special Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20 unless doing so endangers human life or violates safe flying practices. Authorized users of the NPR-A may be restricted from using aircraft larger than a Twin Otter, and limited to an average of one fixed-wing aircraft takeoff and landing per day per airstrip, except for emergency purposes. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter by authorized users of the NPR-A, including oil and gas lessees, from May 20 through August 20 within the Utukok River Uplands Special Area, except for emergency purposes. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will</td></tr>
</table>

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
	be restricted to the minimum necessary to collect such data. 5. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Utukok River Uplands Special Area from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be defined annually by the authorized officer in consultation with the Alaska Department of Fish and Game. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.			

SUMMER VEHICLE TUNDRA ACCESS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
L-1 Required Operating Procedure **Northeast** <u>Objective</u>: Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities. <u>Requirement/Standard</u>: On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in Required Operating Procedure C-2a. Permission for such use would only be granted after an applicant has: a. Submitted studies satisfactory to the authorized officer of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used. These studies should reflect use of such vehicles under conditions similar to those of the route proposed for use and should demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation. b. Submitted surveys satisfactory to the authorized officer of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife and fish (and their habitats), paleontological and archaeological resources, and other resources as required by the authorized officer.	***L-1 Best Management Practice*** <u>Objective</u>: Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities. <u>Requirement/Standard</u>: On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in Best management Practice C-2a. Permission for such use would only be granted after an applicant has: a. Submitted studies satisfactory to the authorized officer of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used. These studies should reflect use of such vehicles under conditions similar to those of the route proposed for use and should demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation. b. Submitted surveys satisfactory to the authorized officer of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife and fish (and their habitats), paleontological and archaeological resources, and other resources as required by the authorized officer.			

SUMMER VEHICLE TUNDRA ACCESS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
c. Designed and/or modified the use proposal to minimize impacts to the authorized officer's satisfaction. Design steps to achieve the objectives and based upon the studies and surveys may include, but not be limited to, timing restrictions (generally it is considered inadvisable to conduct tundra travel prior to August 1 to protect ground-nesting birds), shifting of work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring. At the discretion of the authorized officer, the plan for summer tundra vehicle access may be included as part of the spill prevention and response contingency plan required by 40 CFR 112 (Oil Pollution Act) and Required Operating Procedure A-4. **Northwest** No comparable provision.	c. Designed and/or modified the use proposal to minimize impacts to the authorized officer's satisfaction. Design steps to achieve the objectives and based upon the studies and surveys may include, but not be limited to, timing restrictions (generally it is considered inadvisable to conduct tundra travel prior to August 1 to protect ground-nesting birds), shifting of work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring. At the discretion of the authorized officer, the plan for summer tundra vehicle access may be included as part of the spill prevention and response contingency plan required by 40 CFR 112 (Oil Pollution Act) and Required Operating Procedure A-4. *(Same text as in Northeast NPR-A 2008 Record of Decision)*			

GENERAL WILDLIFE AND HABITAT PROTECTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
No comparable provision.	***M-1 Best Management Practice*** **NOTE**: **This best management practice is only applicable to Alternative B-2**. There would be no comparable provision for any of the other alternatives. Objective: Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A. Requirement/Standard: Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.			
No comparable provision.	***M-2 Best Management Practice*** **NOTE**: **This best management practice is applicable only to Alternative B-2**. There would be no comparable provision for any of the other alternatives. Objective: Prevent the introduction, or spread, of non-native, invasive plant species in the NPR-A. Requirement/Standard: Certify that all equipment and vehicles (intended for use either off or on roads) are weed-free prior to transporting them into the NPR-A. Monitor annually along roads for non-native invasive species, and initiate effective weed control measures upon evidence of their introduction. Prior to operations in the NPR-A, submit a plan for the BLM's approval, detailing the methods for cleaning equipment and vehicles, monitoring for weeds and weed control.			

GENERAL WILDLIFE AND HABITAT PROTECTION

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>No comparable provision.</td><td colspan="4">M-3 Best Management Practice
NOTE: This best management practice is applicable only to Alternative B-2. There would be no comparable provision for any of the other alternatives.
<u>Objective</u>: Minimize loss of populations of, and habitat for, plant species designated as Sensitive by the BLM in Alaska.
<u>Requirement/Standard</u>: If a development is proposed in an area that provides potential habitat for a BLM Sensitive Plant Species, the development proponent would conduct surveys at appropriate times of the summer season and in appropriate habitats for the Sensitive Plant Species that might occur there. The results of these surveys will be submitted to the BLM with the application for development.</td></tr>
<tr><td>No comparable provision.</td><td colspan="4">M-4 Best Management Practice
NOTE: This best management practice is applicable only to Alternative B-2. There would be no comparable provision for any of the other alternatives.
<u>Objective</u>: Minimize loss of individuals of, and habitat for, mammalian species designated as Sensitive by the BLM in Alaska.
<u>Requirement/Standard</u>: If a development is proposed in an area that provides potential habitat for the Alaska tiny shrew, the development proponent would conduct surveys at appropriate times of the year and in appropriate habitats in an effort to detect the presence of the shrew. The results of these surveys will be submitted to BLM with the application for development.</td></tr>
</table>

From:	Reed, Jennifer
To:	Berendzen, Steve
Cc:	Stephen Arthur; Hollis Twitchell; Christopher Latty; Roger Kaye; Jorgenson, Janet; Greta Burkart; Roy Churchwell; Joanna Fox
Subject:	Re: Final Priority Info Needs for 1002 Area document for sharing
Date:	Monday, February 26, 2018 11:45:51 AM

As a follow up to the Thursday, 10am meeting, can you provide staff the individual subject area reports each of us submitted? Thanks!

Jennifer J. Reed
Arctic National Wildlife Refuge Public Use Manager
101 12th Ave, Rm 236
Fairbanks, AK 99701
Telephone: (907) 455-1835
Fax: (907) 456-0428
Interagency Visitor Use Management Council-USFWS Representative
Interagency Wild & Scenic River Coordinating Council-USFWS Representative

Make Your Splash!

NOTE: This email correspondence and any attachments to and from this sender is subject to the Freedom of Information Act (FOIA) and may be disclosed to third parties.

On Mon, Feb 26, 2018 at 9:05 AM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:

> I don't know what identified needs will get funding, or what additional efforts we'll be expending on the resource assessment needs, but thanks for all the work you put into these documents.
>
> Steve Berendzen
> Acting Manager, Arctic National Wildlife Refuge
> 907-456-0253
>
> ---------- Forwarded message ----------
> From: **Socheata Lor** <socheata_lor@fws.gov>
> Date: Mon, Feb 26, 2018 at 7:23 AM
> Subject: Fwd: Final Priority Info Needs for 1002 Area document for sharing
> To: stephanie_brady@fws.gov, john_w_martin@fws.gov, drew_crane@fws.gov, john_trawicki@fws.gov, Mitch Ellis <mitch_ellis@fws.gov>, doug_damberg@fws.gov, steve_berendzen@fws.gov
>
> Thank you and your staff for working on this!

Soch

Sent from my iPhone

Begin forwarded message:

From: "Murphy, Ted" <t75murph@blm.gov>
Date: February 26, 2018 at 6:56:38 AM PST
To: Greg Siekaniec <greg_siekaniec@fws.gov>
Cc: Karen Mouritsen <kmourits@blm.gov>, "Miriam (Nicole) Hayes" <mnhayes@blm.gov>, Karen Clark <karen_clark@fws.gov>, wendy_loya@fws.gov, mary_colligan@fws.gov, socheata_lor@fws.gov
Subject: Re: Final Priority Info Needs for 1002 Area document for sharing

Thanks Greg

Ted

On Sun, Feb 25, 2018 at 8:16 PM, Greg Siekaniec <greg_siekaniec@fws.gov> wrote:

> Ted,
>
> Please find attached the priority information needs that have been identified by the multi-agency team, and others, regarding the coastal plain of Arctic Refuge. We have also included the earlier document concerning science needs for polar bear that was requested immediately following the passage of the Tax Act. The request was made knowing there are requirements of the endangered species act and marine mammal protection act that will need to be addressed in planning and permitting.
>
> I did not want to combine the two documents at this time as it would likely confuse the discussion, and I'm not certain of the priority of polar bear science timing as it relates to the additional items noted for the area.
>
> This should be viewed as a "living" document that may need some changes as we learn more of what it will take to conduct seismic/geophysical and development. We may be able to combine into "one" document if we can pull the planning group and subject matter experts together for discussions.
>
> Thank you for your patience in letting us develop this as we engaged several disciplines and knowledgable experts in the field of conservation and oil and gas development.
>
> Please call with questions and we look forward to continuing to work towards your initiation of environment planning.
>
> Greg

<ATT00001.html><Priority Information Needs for the Arctic National Wildlife Refuge 1002 Area DRAFT v1 022518 docx.docx>

--
Ted A Murphy
Alaska-Associate State Director
907-271-5076

Priority Information Needs for the Arctic National Wildlife Refuge 1002 Area

Date: February 25, 2018

From: Gregory Siekaniec, Regional Director – Alaska Region

Subject: Research Gaps Identified by Fish and Wildlife Service and other agency technical experts to inform Arctic Refuge Coastal Plain Oil and Gas Program Environmental Impact Statement

I. Introduction

Staff from the USFWS in Alaska led the compilation of "Resource Assessments" for the Arctic National Wildlife Refuge 1002 area from January 9 – February 16th, 2018. The FWS staff lead consulted other technical experts from Bureau of Land Management, US Geological Service, Bureau of Ocean Energy and Management, National Oceanic Atmospheric Administration, multiple State of Alaska agencies, the North Slope Borough, oil and gas Industry, Canadian federal and territorial agencies and other institutions to identify the types of information that the BLM and FWS are likely to need in planning, developing, and managing an oil and gas program in the 1002 area with respect to natural resources, subsistence and community health. Compilation of these detailed assessments is underway and may serve as the basis for a 5-year science plan for the 1002 area.

Primary topics for the Resource Assessments include: soils, permafrost, wetlands, & vegetation; coastal resources; climate & snow; air quality; water resources; acoustic environment; contaminants; oil spills; caribou; other terrestrial mammals; fisheries; birds; subsistence; public health; visitor use; cultural resources; and paleontological resources.

To identify immediate needs, FWS staff within the Arctic program of the Office of Science Applications convened Refuge managers, regulatory experts and biologists to develop a prioritization framework for the full list of recommended studies in the Resource Assessments.

II. Priority Information Needs by Subject

In addition to the Polar Bear Information Needs in the 1002 Area already submitted (following Page 4 in this document; pages PB 1-6), ten studies were identified as a priority for: 1) meeting near-term regulatory requirements; 2) informing the BLM-led Environmental Impact Statement for the 1002 area; and/or needed to permit/inform seismic exploration.

The following table describes the Purpose, Need and Recommended Action, Projected Annual Cost and likely Duration for filling immediate information needs. FWS staff will work with BLM and all available and/or relevant partners to finalize study designs. Costs identified are estimates for project implementation.

Table 1. Recommended Fiscal Year 2018 Activities for Information Collection in Relation to Oil and Gas Development in the 1002 Area of the Arctic National Wildlife Refuge for Natural Resources, Subsistence and Human Health, in addition to previously identified Polar Bear studies

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years
Water/ Wetlands/ Vegetation	Develop an updated Wetlands Inventory Map, including watershed map, and a Vegetation Map	To permit and/or guide seismic, tundra travel, water/snow use and infrastructure planning; Section 404 Permits	There is significant efficiency and cost savings in the coordinated development of a wetlands map with associated hydrography, and a vegetation map, as much of the cost is associated with field work to validate the classifications. The 1002 area needs an updated National Wetlands Inventory assessment that our Ecological Services division uses in every BLM or Corp of Engineers project. Coupling that with National Hydrologic Database Hydrography mapping is important to understanding the hydrology, especially recharge of lakes and rivers, and habitat in the 1002 area which is very different than NPRA. An accurate, updated vegetation map is essential for working with Industry to permit seismic and winter tundra travel, as the vegetation of the 1002 area is much taller and more diverse than the coastal plain of the NPRA, including large areas of tussock tundra which is highly susceptible to damage. When NSSI updated the North Slope Vegetation Map in collaboration with Ducks Unlimited, the 1002 area was not field-validated and is the map for 1002 area is lower accuracy, and thus insufficient to meet planning needs. FWS would work with BLM and others to produce complimentary wetlands/hydrography and vegetation maps. Timeline to completion is approximately 1.5 to 2 years. Cost estimate would cover all work and could include both agency staff and a contractor.	$350K -$450K	1
Caribou	Analyze existing telemetry data to quantify seasonal ranges and migration routes	To inform the EIS; to meet the intent of species conservation in ANILCA and the Int'l Agreement for Conservation of Porcupine Caribou Herd	A large database of telemetry data exists that will provide valuable baseline information on caribou movements and habitat selection. These data need to be formally analyzed to update the report "Sensitive Habitats of the Porcupine Caribou Herd" (International Porcupine Caribou Board, 1993); this information is needed to identify sensitive areas that may require special management during development and production. Funding is for time for a wildlife ecologist to analyze data and prepare a peer-reviewed report..	$50,000	1
Caribou	Monitor caribou movement to understand habitat use prior to development	To meet the intent of species conservation in ANILCA and the Int'l Agreement for Conservation of Porcupine Caribou Herd	Monitoring data are needed to identify calving areas and seasonal ranges and to quantify caribou recruitment and survival; pre-development data will be used to work with industry to ensure habitat connectivity where possible.	$250,000	5

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years
Birds	Provide contemporary information on distribution and abundance and important habitat areas for birds	To ensure compliance with Migratory Bird Treaty Act and identify important bird habitat in the EIS	Conduct aerial- or ground-based inventories of breeding birds. Species groups should include waterfowl, loons, gulls, shorebirds, and landbirds and should also include both area-wide and site-specific surveys. Prioritization of surveys should be based on conservation needs. Because this information may be important to leasing, and because year-to-year variability will require baseline data to be collected over several years, surveys should begin as soon as possible.	$175,000	3
Snow/ Weather	Create and/or Evaluate Snow Distribution Models to capture snow depth across the 1002 Area	To be able to identify annually snow drifts with highest probability to create potential polar bear denning habitat (MMPA/ESA); to establish minimum snow required for winter tundra travel to protect taller stature vegetation in 1002 area during exploration and development.	Snow depth and drifting monitoring and calibration of snow model for 1002 area. A combination of snow, wind and temperature monitoring stations and ground surveys, as well as high-resolution digital elevation models will be necessary to create a more accurate snow model for the 1002 area. UAF has received funding from NASA to collect aircraft-based imagery of snow levels in April 2018, and funding is needed for fuel, lodging and ground-truthing by snowmachine surveys. This would provide a preliminary baseline for snow depth in polar bear denning habitat and for winter tundra travel. Continued operation of 3 remote meteorological stations provides continuous temperature, wind and precipitation (including snow). Addition of 2-3 NRCS operated SNOTEL sites would improve spatial coverage. This information, coupled with requested vegetation map and high resolution topography (DEM) map would be used to plan future monitoring and aerial imagery acquisition to inform an improved snow model such as the SnowDens 3D Model developed by Dr. Glen Liston for the FWS through a previous NFWF grant.	2018: $40K;$30-100k SNOTEL initiation (NRCS contribution would decrease)/ $13k per annum SNOTEL operation	1+
Water	Characterize seasonality in water quantity and quality in primary rivers of 1002 area.	Understanding river flow is needed to inform transportation planning and water withdrawal permitting, and is therefore part of the EIS	Conduct continuous water quality and quantity monitoring on the Hulahula, Tamayariak, and Canning rivers to evaluate the current status and natural variability in late fall and spring surface water quality and quantity in relation to the timing of fish use and industrial activity. Compile information in a database that will be used for permitting and impacts analyses.	$175,000	5
All Natural Resources	Extract information from existing technical reports and put into modern geospatial database. Ensure Documents are in a common repository.	Build off the existing science investment to expedite EIS	Cross reference existing technical reports to map any known areas of special values including Wild and Scenic Rivers, springs, subsistence use areas, and recreational areas (e.g. Canning River takeout). Identify data gaps in our knowledge in addition to those mentioned previously. The North Slope Science Initiative (NSSI) catalogue would be a possible location for the repository. Funding is for staff time or contractor to design database and compile information.	$30,000	1

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years
Public Health	To understand the benefits and impacts of oil and gas exploration and development on communities in and around the 1002 area of the Arctic National Wildlife Refuge	Requirement or standard practice for North Slope EIS	The Liberty Draft EIS and Point Thompson Final EIS both include Health Impact Assessments for Kaktovik that may be further evaluated for site specific and cumulative effects for Kaktovik as well as other communities in or adjacent to the refuge (Arctic Village, Venetie) or those that rely on natural resources from the Refuge. Health Impact Assessments should include evaluation of: Social Determinants of Health; Accidents and Injuries; Exposure to Potentially Hazardous Materials; Food, Nutrition, and Subsistence Activity; Infectious Disease; Water and Sanitation; Non-communicable and Chronic Diseases; and Health Services Infrastructure and Capacity. Funding request would be to secure a contractor to complete Health Impact Assessments.	$50-$100K	1
Subsistence	Compile new and historical information on archaeological, ethnographic and subsistence work that has been completed for Arctic Refuge 1002 area in a database and ensure associated documents are catalogued.	To provide information needed EIS and for Sec 810 analysis.	Create a functional repository and database of existing contemporary and historical data. Multiple sources of published and unpublished subsistence use and harvest data reside with various agencies, organizations, tribal governments, and universities. The North Slope Science Initiative (NSSI) catalogue would be a possible location for the repository. Funding is for staff time or contractor to design database and compile information.	$50,000	1
Subsistence	Establish a Subsistence Harvest Monitoring Program	To ensure long-term conservation of fish and wildlife subsistence species and subsistence uses for qualified subsistence users (ANILCA)	Alaska Department of Fish and Game intermittently interviews year-round households in a community to understand the quantity of subsistence harvest for all natural foods (e.g. fish, land mammals, marine mammals, etc.). A full study has not been done since 1992. In the absence of contemporary information and to understand evolving subsistence harvest, a community supported harvest monitoring program with implementation protocols based on timely and accurate harvest information is needed for communities relying on resources associated with the 1002 area, including caribou, fish, furbearers, birds, berries, etc..	$50,000 - $100,000	I

POLAR BEAR INFORMATION NEEDS IN THE 1002 AREA

Statement of the Challenge: Making required determinations under the MMPA and ESA given data gaps, the declining status of the Southern Beaufort Sea subpopulation, increased land use, and the density of polar bear dens in the 1002 area.

Consideration of Required Determinations under the ESA and MMPA:

MMPA: We can specify the incidental, but not intentional, taking of **small numbers** of polar bears by harassment if we can find that such harassment will have a **negligible impact** on the stock of polar bears and will not have an unmitigable adverse impact on the **availability of polar bears for subsistence uses** (emphasis added).

ESA: Under Section 7 of the ESA we will have to conduct consultations on federal action(s) and will have to make a determination as to whether such actions would **jeopardize** the continued existence of polar bears or **adversely modify or destroy** designated critical habitat (emphasis added).

Primary Data Gaps:

- Consistent monitoring of abundance, survival, and reproduction of polar bears
- Intensity of habitat use (both denning and summer/autumn land use) in the 1002 area
- Trends in denning in the 1002 area
- Applicability of existing management measures inside the 1002 area

Making the above determinations requires (i.e. What do we need to know and why do we need to know it?):

- Population dynamics
    - An accurate and current understanding of the population dynamics of the Southern Beaufort Sea subpopulation of polar bears is needed in order to estimate the impact of anticipated take (i.e. to determine small numbers and make negligible impact determinations under MMPA and jeopardy determinations under ESA).

- Habitat Ecology
    - Understanding the relationship between polar bears and environmental parameters helps us explain current habitat use patterns and make future predictions on how distribution and movement is likely to respond to predicted sea ice loss and other habitat changes. This understanding is needed in order to predict how many and how animals are likely to be impacted by proposed activities (small numbers and negligible impact determination under MMPA) and whether proposed actions are likely to adversely modify or destroy designated critical habitat (ESA determination).

- Subsistence and Cultural Use of Polar Bears
    - An activity or suite of actions can affect the availability of polar bears for subsistence use by decreasing the overall number of animals or by changing their movements.
    - Understanding polar bear movements and current hunting practices helps us understand the current availability of polar bears for subsistence hunting and predict the potential impact of proposed actions on the availability of polar bears for subsistence use (MMPA determination).
    - Maintaining clear and consistence communications and relationships with communities concerning ongoing research and development activities.

- Human-Polar Bear Interactions
    - Understanding the potential spatial and temporal overlap between polar bears and oil and gas development and the factors influencing the likelihood and consequences of interactions between polar bears and those development activities is essential to our ability to determine the number of polar bears likely to be taken (small numbers determination under MMPA) and the consequences of that take to the

individual animal and ultimately the stock (negligible impact determination under MMPA) and to the species (jeopardy determination under ESA).

- Identification of possible methods to avoid overlap and interactions between polar bears and Industry activities, and to reduce the potential for interactions, are essential tools to facilitating our ability to achieve a small numbers determination and reach a negligible impact determination (MMPA) as well as avoid jeopardy and adverse modification or destruction of critical habitat (ESA).

Priority research, analyses, and actions that are needed throughout the life of the project to obtain the above information required to make annual determinations.

1. Population Dynamics
    a. Estimation of abundance and population dynamics (i.e. demographic rates such as survival and reproduction). Surveys using mark-recapture methods are a more viable option than other non-invasive techniques (e.g., aerial survey).
    b. Continue to evaluate emerging technologies (e.g., high-resolution satellite imagery, GPS collar reliability, collar drop off mechanism performance) for integration into existing monitoring plans.

2. Habitat Ecology
    a. Improve our understanding of the environmental and biological characteristics of important polar bear habitats, with a particular focus on denning habitat.
        i. Continue, expand, and improve den detection, mapping, and monitoring activities. We see higher use of habitat within the 1002 area and greater reproductive success for land-based dens.
        ii. Identify movement and land use patterns of polar bears in the 1002 area, and projected changes due to sea ice loss, especially given the increased proportion of the population coming on shore in that region. Identify potential for habitat use and behavioral patterns to be modified due to increased human activities.

3. Assess Impacts to Subsistence and Cultural Use of Polar Bears
    a. Periodically assess key community perspectives, values and needs regarding human-polar bear interactions and sustainable use of polar bears for subsistence purposes.

4. Human-Polar Bear Interactions – Identify Current Methods and Develop New Methods to Avoid, Reduce and Mitigate impacts to Polar Bears from Oil and Gas Development Specific to the 1002 Area
    a. Understand how polar bears respond to disturbance
        i. Use existing movement data to look at relationships with existing infrastructure (does it appear bears are avoiding those areas and if so what is the impact zone)
        ii. Monitor for potential disturbances at den sites
    b. Evaluate efficacy of mitigation measures currently used outside of the 1002 area to determine effectiveness and transferability to the 1002 area
        i. Comprehensive Review of Management Measures (e.g., season/area restrictions, den buffer zones, facility location/design)
        ii. Avoidance: Examine available data to identify areas of particularly high use or biological importance for seasonal or year round avoidance areas
    c. Develop new mitigation measures specific to the unique characteristics of the 1002 area to reduce the number of bears taken and the overall impact of Industry.

First Year Cost: $2.7M

Total Estimated Annual Cost FY19 - Indefinite: $5 million

Table 1. Timeline and Costs Associated with Information Collection on Polar Bears in Relation to Oil and Gas Development in the 1002 Area of the Arctic National Wildlife Refuge.

Priority Information Needs	Project Title and Details	Implementation Timeline	Cost
Population Dynamics	*Modernization of Satellite Radio Collars (FWS/USGS)* • Identify performance standards and work with potential vendors to improve existing satellite radio collars.	January – December 2018	$250,000
	Development of a Population Monitoring Plan for SBS Polar Bears (FWS/USGS) • Develop a rigorous long-term population monitoring plan, including the use of mark-recapture techniques and satellite radio collaring. • Requires working with Canada as this sub-population occurs in both countries • Likely would require the U.S. to fund work in both countries.	January 2018 – December 2018	$200,000
	Implementation of Population Monitoring Program for SBS Polar Bears (FWS/USGS) • U.S. and Canada fieldwork to include helicopter based captures, satellite collaring, DNA analyses, health assessment, and hiring of field crews. • Conduct associated analyses and community coordination. • Secure permits and authorizations.	Annually Beginning January 2019	$2,500,000
Habitat Ecology	*Development of an Annual Den Detection and Monitoring Plan for the 1002 Area (FWS/USGS)* • Analyze existing information on den occurrences in the 1002 Area.	January – October 2018	$150,000
	Implementation of Polar Bear Den Detection and Monitoring Plan for the 1002 Area (FWS/USGS) • Conduct annual den detection surveys of all potential denning habitat in the 1002 Area. • Conduct analyses to identify the characteristics of environmental and biological characteristics of polar bear denning habitat. • Develop a model to make future predictions concerning polar bear denning. • Assess effectiveness of existing and experimental den detection survey methods.	November 2018 – December 2021	$1,300,000

Priority Information Needs	Project Title and Details	Implementation Timeline	Cost
Habitat Ecology	*Movement and Habitat Use Patterns of Polar Bears in the 1002 Area (FWS/USGS)* • This project would require the use of satellite collaring data collected in the Population Monitoring Program outlined above, as well as the den detection data collected in the Den Detection and Monitoring project also outlined above. • Conduct analyses to identify current movement and habitat use patterns of polar bears in the 1002 Area. • Develop models to predict polar movement and habitat use changes over time. • Provide polar bear movement data and habitat use information to Industry to reduce the potential for human polar bear conflicts in the 1002 Area.	Annually Beginning January 2019	$250,000
Assess Impacts to Subsistence and Cultural Use of Polar Bears	*Community Perspectives and Use of Polar Bears in the 1002 Area (FWS)* • Design and implement studies to assess community perspectives regarding human-polar bear interactions and sustainable use for subsistence purposes.	Annually Beginning 2018	$200,000
Human-Polar Bear Interactions	*Polar Bear Response to Anthropogenic Disturbance (FWS)* • Use existing data from Prudhoe Bay and NPR-A to analyze the relationship between infrastructure and polar bears. • Design and implement a project to monitor sound levels and other forms of disturbance at polar bear den sites and concomitant polar bear response and denning success.	January 2018 – December 2021	$450,000
	Evaluate Efficacy of Existing Mitigation Measures (FWS) • Comprehensive review of management measures applied to existing Industry operations (i.e. buffer zones, seasonal/area restrictions, facility location/design). • Utilizing the Habitat Ecology program outlined above, identify areas of high use or biological importance in the 1002 area.	January 2018 – December 2021	$150,000
	Development of New Mitigation Measures specific to the 1002 Area (FWS • Informed by the previous two projects, modify current mitigation measures and develop novel measures to address characteristics unique to the 1002 Area.	January 2019 – December 2021	$150,000

Table 2. Implementation of Fiscal Year 2018 Activities for Information Collection on Polar Bears in Relation to Oil and Gas Development in the 1002 Area of the Arctic National Wildlife Refuge (Positions are budgeted on a 12-month time period which reflects current costs if the need is addressed through contracting).

Project Title	Description	Methods	Cost
Modernization of Satellite Radio Collars ***(FWS/USGS)***	The use of satellite radio collars is essential to our ability to gather information on polar bear population dynamics and habitat use patterns. However, current satellite radio collars utilize an unreliable release mechanism such that collars that are past their functional life are not falling off the animals. Because of this, the public has expressed serious concerns about the use of satellite radio collars for monitoring polar bear populations.	Issue a Request for Proposals (RFP) for development of a reliable collar release mechanism to insure that satellite radio collars reliably release from the animal when they are past their functional life.	$250,000
Development of a Population Monitoring Plan for SBS Polar Bears ***(FWS/USGS)***	This task has multiple actions that would need to occur routinely over multiple years including development of the monitoring plan, implementation of an annual field research effort, analysis of data, and routine updates to the monitoring plan which would facilitate more accurate and precise estimates of population size and demographic rates through time.	Hire a GS-11/12 research biologist to develop and implement the monitoring plan.	$150,000
		Meet with Canadian researchers and managers to develop a joint study plan, determine roles and responsibilities for implementation and funding.	$35,000
		Meet with Alaskan Native subsistence hunters to discuss methods and timing of study.	$15,000
Development of an Annual Den Detection and Monitoring Plan for the 1002 Area ***(FWS/USGS)***	Analyze existing information on den occurrences in the 1002 Area.	Hire a GS 11/12 research biologist to review data from collared bears as well as update habitat modeling using modern satellite technology such as LIDAR.	$150,000

Project Title	Description	Methods	Cost
Implementation of Polar Bear Den Detection and Monitoring Plan for the 1002 Area *(FWS/USGS)*	Conduct pilot FLIR surveys in February 2018 on a section of coastline in the 1002 area and selected riverbeds.	Issue an RFP for FLIR surveys to be conducted during February of 2018.	$750,000
		Secure additional server capacity for FLIR images and hire a GS 11/12 computer technician to help process imagery.	$250,000
		Hire a GS11/12 biologist to process imagery and analyze den detection survey data.	$150,000
	Assess effectiveness of existing and experimental den detection survey methods.	Hire a GS 11/12 to develop a plan to test for false positives and false negatives in den detection surveys in order to develop a correction factor.	$150,000
Community Perspectives and Use of Polar Bears in the 1002 Area *(FWS)*	Develop study design and begin implementation for baseline data collection.	Issue a RFP for study design and implementation	$200,000
Polar Bear Response to Anthropogenic Disturbance *(FWS)*	Use existing data from Prudhoe Bay and NPR-A to analyze the relationship between infrastructure and polar bears.	Hire a GS 7/9 biologist to query existing data and a GS 11/12 biologist to analyze that data.	$250,000
	Design and implement a project to monitor sound levels and other forms of disturbance at polar bear den sites and concomitant polar bear response and denning success.	Hire a GS 9/11 acoustician and acquire sound monitoring and camera systems for den monitoring.	$200,000
Evaluate Efficacy of Existing Mitigation Measures *(FWS)*	Comprehensive review of management measures applied to existing Industry operations (i.e. buffer zones, seasonal/area restrictions, facility location/design).	Hire a GS 9/11 biologist to compile review and document basis for existing management measures and their efficacy in the field.	$100,000
		Utilize 50% of a GS 9/11 biologist to investigate possible application of existing management measures to the 1002 area.	$50,000

From: Arthur, Stephen
To: Berendzen, Steve
Cc: Hollis Twitchell; Christopher Latty; Jorgenson, Janet; Roger Kaye; Greta Burkart; Roy Churchwell; Reed, Jennifer; Joanna Fox
Subject: Re: Arctic Refuge 1002 Area Resource Assessments: 2018 Priority Information Needs
Date: Monday, February 26, 2018 1:36:26 PM

For those who are interested, the message below provides the path to a network directory where all the resource assessments are stored.

Stephen M. Arthur, Ph.D.
Supervisory Wildlife Biologist
Arctic National Wildlife Refuge
101 12th Ave., Room 236
Fairbanks, AK 99701
(907)455-1830

---------- Forwarded message ----------
From: **Wendy Loya** <wendy_loya@fws.gov>
Date: Thu, Feb 15, 2018 at 12:35 PM
Subject: Drive Location for uploading 1002 Arctic Refuge Resource Assessments

Dear Resource Assessment Team Leads:

We have established a shared folder on the R7 Common Drive for the 1002 Arctic Refuge Program (Oil and Gas). It should look like this, and you can use FWS Tools to go in your computer menu to get to a link called Drives, which leads to a link to Remap Drives and Printers. Let me or John Trawicki know if you are unable to find the folder.

r7common(\\ifw7rofs1.fws.doi.net)(P:)\1002ArcticRefuge\1-Working\Resource Assessments_Originals

Everyone in the region should have read/write access to this folder, and I would like to request that you please save a copy of your final document there in addition to emailing it to John Martin. If you have already submitted, John Martin will save the copy he has received there today. This will allow us to work with these immediately and keep common record of the effort.

Thank you,
Wendy

FOIA Note: See pages 613-733 for documents referenced in this email.

Dr. Wendy M. Loya, Coordinator
Arctic Landscape Conservation Cooperative (LCC)
Anchorage, Alaska
907.786.3532 (office)
907.227.2942 (mobile)

Stephen M. Arthur, Ph.D.
Supervisory Wildlife Biologist
Arctic National Wildlife Refuge
101 12th Ave., Room 236
Fairbanks, AK 99701
(907)455-1830

On Mon, Feb 26, 2018 at 10:30 AM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:

I'm forwarding Wendy's email and attached listing of prioritized needs for the 1002 area. Many of the needs that were identified by some of you are not on this list, but we will hopefully get all of the prioritized needs addressed through this effort.

Jen recently asked about the resource assessments that were submitted to the RO, and could they be shared with all staff? I don't have access to the final versions of those, and I might not have seen every one of those before going to the RO. I think John Martin compiled those, but not sure - Wendy and Paul Leonard worked on them as well. I'm sure we can get access to them at some point, but I know that Wendy was focused on teasing out the priority needs and developing the associated cost estimates.

Steve Berendzen
Acting Manager, Arctic National Wildlife Refuge
907-456-0253

---------- Forwarded message ----------
From: **Wendy Loya** <wendy_loya@fws.gov>
Date: Mon, Feb 26, 2018 at 9:58 AM
Subject: Arctic Refuge 1002 Area Resource Assessments: 2018 Priority Information Needs
To: Drew Crane <drew_crane@fws.gov>, Eric Taylor <eric_taylor@fws.gov>, Joanna Fox <joanna_fox@fws.gov>, John Trawicki <john_trawicki@fws.gov>, Stephanie Brady <stephanie_brady@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, John Martin <john_w_martin@fws.gov>, Paul Leonard <paul_leonard@fws.gov>, Greta Burkart <greta_burkart@fws.gov>, Angela Matz <angela_matz@fws.gov>, Mark Miller <memiller@blm.gov>, Janet Jorgenson <janet_jorgenson@fws.gov>, Randy Brown <randy_j_brown@fws.gov>, Christopher Latty <christopher_latty@fws.gov>, Stephen Arthur <stephen_arthur@fws.gov>, Edward Decleva <edward_decleva@fws.gov>, Tracy Fischbach <tracy_fischbach@fws.gov>, Jennifer Reed <jennifer_reed@fws.gov>, Sara Longan <sara.longan@alaska.gov>, Hollis Twitchell <hollis_twitchell@fws.gov>, Roger Kaye <roger_kaye@fws.gov>, Ted Swem <ted_swem@fws.gov>, Joshua Bradley <joshua_bradley@fws.gov>
Cc: Sarena Selbo <sarena_selbo@fws.gov>, Mary Colligan <mary_colligan@fws.gov>, bud_cribley@fws.gov, Doug Damberg <doug_damberg@fws.gov>, Carl Johnson <carl_johnson@fws.gov>, Sarah Conn <sarah_conn@fws.gov>

Dear Colleagues,

Attached is a list of the studies that were submitted yesterday by Greg Siekaniec to BLM per their request at the January 19th Oil and Gas overview. At that meeting, BLM asked on the spot what our priority information needs were to get to an EIS for Oil and Gas for the 1002 area. We deferred until you all had the chance to compile the Resource Assessments you completed by February 16th.

The Resource Assessments are very good, and show the effort that you all took in reaching

out to BLM Arctic Field office staff and other experts to understand what information we need to make decision, identifying what we have and studies that will help fill knowledge gaps. When compiled all together, we had over 86 recommended studies.

I then worked with your division points of contact (Drew Crane, Eric Taylor, John Trawicki, Steve Berendzen, and Joanna Fox) as well as Steve Arthur, Sarah Conn and Paul Leonard to identify a prioritization framework. Paul and I further consulted with the NPRA Table 2.3 Stipulations; BLM Arctic Field Staff, industry, FWS staff and others to come up with a list of 10 Studies, *not including Polar Bears*, that appear to be needed to: 1) meet an near-term regulatory need, 2) needed to identify Stipulations/BMPs in writing the EIS or completing the EIS in other ways, or 3) pertained to Exploration (primarily seismic activity).

Thus, our focus was on needing to start now to have information in the next few months to next 2 years. We combined some studies recommended separately, and that changed some budgets that were provided. The details of most of the studies in the table need to be fleshed out, and we need a budget(!). Paul and I will work with you all to share what further information we may have and help facilitate those conversations with additional partners as needed. Polar Bears were removed from consideration as high priority studies as those research needs had already been identified and submitted to BLM/FWS.

You won't see all of the important work that was recommended in the table, but that does not mean it shouldn't be done. We thought some of it could wait a little while, even if just a year. Other studies may be done by industry once they hold leases in as soon as 2 years. Also, note that it may take about 10 years to begin development, so we have time to start baseline studies for pre-development data, which will be one of our next priorities. We'll know more about the potential economically recoverable oil estimates when USGS completes its re-analysis of the vintage 2D seismic later in 2018, and that and the information we hope to collect from the studies in the Priority Information Needs Table will help us target our studies starting in 2019.

John Martin, Paul Leonard and I will continue to work with you all to compile the full Resource Assessments into a science plan for the Arctic Refuge 1002 Area. It will be a "living" document as we learn more and work with BLM on the EIS for Leasing, once that starts.

I welcome any questions you have about the process or list.

Sincerely

Wendy

Dr. Wendy M. Loya,

Arctic Program Coordinator, Office of Science Applications

US Fish and Wildlife Service

Anchorage, Alaska

907.786.3532 (office)

907.227.2942 (mobile)

From:	Burkart, Greta
To:	Churchwell, Roy
Cc:	Stephen Arthur; Christopher Latty; Janet Jorgenson; Paul Leonard; John Trawicki
Subject:	Re: Critical Habitat exercise
Date:	Tuesday, February 27, 2018 11:01:34 AM

Hi Roy and everyone -

Roy - Thanks for sending the draft map of critical habitats in the 1002 area (I have reattached it to this email). I agree that using 0.5 mile buffer for all waterbodies would be more reasonable than approaches previously used by BLM to manage other lands since the original purposes of the Arctic Refuge give it a higher level of protection than BLM managed lands. I

do, however, think we need larger buffers around the high-value habitats that have already been identified: springs and associated features (deep pools, open water, and aufeis), the six known lakes that have sensitive fish species, proposed Wild Rivers (Canning and Hulahula), and the long-term monitoring sites at Jago Bitty, Canning River Delta and Nuvagapak Lagoon. For these high-value areas it would make more sense to use larger buffers and/or the entire upstream watershed. We could also include potential fish-bearing waters as high-value habitats since we do not have adequate data on fish presence to identify high-value habitats. I recently found a dataset of all of the lakes in the Refuge that do not freeze to the bottom (shapefile and report can be accessed here: http://catalog.northslopescience.org/catalog/entries/4782-nssi-lakes-data-mapping-winter-l). Until we have better data on fish distribution, I suggest we consider these lakes to be potentially high-value fish habitat.

Unfortunately, coming up with a way to identify potentially high-value waterbird and invertebrate habitat is much trickier, which is why we should consider identifying highly vulnerable habitats that need special protection. For example, lakes would be particularly vulnerable to water or ice withdrawal if they do not adequately recharge following snowmelt. We can assess a lakes potential to recharge following snowmelt using end-of season snow pack data and an analysis of digital elevation models. If the analysis indicates they a lake is vulnerable to water or ice withdraw, it should get special protection, especially since we lack the information necessary to identify habitat value.

We also need to think about what actions should be taken within different buffers (e.g. no surface disturbance, no permanent infrastructure, no leasing, exclusion from right-of-ways, etc). Below, I have noted selected actions from from the NPRA-EIS, November draft of the CYRMP actions under alternative B, and actions that could help ensure protection of special resource in the Arctic Refuge:

Springs --

- NPR-A: springs not considered
- CYRMP: No surface disturbing activities and right-of-way avoidance within 160-acre buffer of springs (Alternative C = 1,000 foot buffer)
- Arctic Refuge 1002 area: The buffer around springs and associated habitat features (spring source, aufeis, deep pools, open water) should be at least five miles. In addition, the entire upstream watershed area flowing into the spring and associated features should be included in the buffer. The following should be completely excluded from the buffer/watershed: surface disturbing activities, surface occupancy, leasing, water/ice withdrawal, and right-of-ways. Subsurface disposal of hazardous wastes is prohibited in the 1002 area

because groundwater flowpaths have not been delineated and there could be great potential to have adverse impacts on springs and/or discharge to the Marine Protected Area.

Lentic waterbodies

- NPR-A: Exploratory drilling prohibited in fish bearing lakes. No permanent facilities within 500-feet of high-water mark. No refueling within 500 feet of the active floodplain of any waterbody. When no fish are present, up to 35% of the total volume can be withdrawn as ice aggregate or water. If sensitive fish are present, 15% of the volume below 7' of ice can be withdrawn as ice aggregate or water. If blackfish or ninespine stickleback are the only fish present 30% of the volume below 5' of ice can be withdrawn.
- CYRMP: Right of way avoidance and no surface disturbance within 0.25 miles of lentic waterbodies.
- Arctic Refuge 1002 area: Because waterbodies are rare and we have little information on high-value habitats in the 1002 area, we should consider the 0.5 mile buffer Roy has drawn and exclude these areas from leasing, surface occupancy, drilling, right-of-ways and anything that may disturb hydrology. Another option would be to consider the entire watershed of the lake to be the buffer - in some cases, this would be smaller than a 0.5 mile buffer. Additional actions would apply to the few high-value lakes that have been identified (see high-value watersheds below). No water or ice withdrawals from lakes with sensitive fish species. No more than 15% of the volume below 7 feet of ice can be withdrawn from lakes with ninespine stickleback or Alaska blackfish. No more than 10% of the total volume of fishless lakes can be withdrawn as ice aggregate. Up to 25% of the total volume of fishless lakes can be withdrawn if the applicant has sufficient data indicating that complete lake recharge will occur with a probability of 95%. No compaction or removal of snow on fish-bearing lakes.

Streams, rivers, and floodplains --

- NPR-A: No exploratory drilling in the active flood-plain. No permanent structures within 500-feet of ordinary high watermark. No refueling within 500 feet of the active floodplain. Water withdrawal from rivers and streams is prohibited. Removal of ice aggregate from grounded areas may be authorized on site-specific basis. Cross waterways at a low-angle approach. Snow and ice bridges must be removed, breached or slotted. Encouraged to travel 100 feet from known overwinter habitat. Ramps and bridges must be debris-free. No gravel extraction in the active floodplain or gravel sites within floodplain can be used to serve as water reservoir and potential site to enhance fish and wildlife habitat. Gravel site design and reclamation must be in accordance with approved officer. Three years of hydrologic data shall be collected by the lessee to ensure safe passage of fish for any proposed stream crossing structure whose structure is designed to occur fully or partially below the ordinary high water mark.
- CYRMP: Avoidance of right-of-ways and no surface occupancy within 100-year floodplains.
- Arctic Refuge 1002 area: Right-of-way avoidance, and no surface occupancy, or drilling within 100-year floodplain or 0.5 mile buffer, whichever is greater. No withdrawals of water or ice from rivers or streams. No ice bridges and no travel over ice that is not frozen to the substrate. Gravel extraction sites, gravel use sites, and reclamation must be in accordance with a USFWS approved officer and must undergo a thorough NEPA process informed by science that can guarantee with a 95% probability that fish and wildlife habitat will not be impacted. At least ten years of hydrologic data and 30-year climate projections are necessary to develop requirements to ensure adequate fish and

surface flow passage in watersheds. Requirements for biological surveys prior to activities??

High-value watersheds:

- NPR-A EIS: No permanent structures within a certain distance of high-value rivers (0.5 to 5 mile setbacks from the ordinary high water line, center line, or other feature, depending on the river). No permanent structures within 0.25 miles of the ordinary high water mark of lakes greater than 4 meters deep. Teshekpuk Lake and the islands within the lake will not be available for leasing. No activity near Elson Lagoon, Admiralty Bay, Dease Inlet or barrier islands from 15 May to 15 October. Water withdrawals are limited to 15% of the volume below 7' of ice or 30% of the volume below 5' of ice for lakes with sensitive and non sensitive fish species, respectively. No compaction or removal of snow on fish bearing waters except at approved ice-road crossings, water pumping stations, and areas of grounded lakes.
- CYRMP: Closure to leasing and right-of-ways within the 100-year floodplain of high value watersheds (note - the first draft of the CYRMP included the entire watershed as a buffer, which makes more sense since you cannot ensure protection of resources without considering a watershed scale)
- In the Refuge, at a minimum, the entire watershed of high-value lakes and rivers should be considered as a buffer zone since impacts anywhere in the watershed can have cumulative impacts on downstream ecosystems and because climate change could be a synergistic stressor. High-value watersheds should be closed to leasing, surface occupancy and right-of-ways should be excluded. High-value watersheds would include the large watersheds of Wild Rivers and springs and the smaller watersheds supporting other high-value fish habitat (e.g. lakes that do not freeze to the bottom), high-value waterbird habitat, visitor use areas, subsistence areas, and long-term monitoring sites (e.g. Jago Bitty, Beaufort Lagoon, and Canning River delta). Additional setbacks may be necessary for some rivers depending on the value and/or the accuracy of data. No activity in Hulahula River or Sadlerochit River watersheds from 1 October to 1 June.

Vulnerable lake and stream habitat:

- CYRMP and NPRA EIS: I don't think vulnerable habitats were addressed
- In the Refuge, vulnerable habitats include lakes that may not recharge adequately following removal of ice or water or redistribution of snow by snow fences in nearby watersheds. Anything that alters hydrology supporting vulnerable habitats should be prohibited. This is especially important given that we have very little knowledge of what habitats are of the highest value to fish and waterbirds. Actions would exclude water/ice extraction, gravel extraction, and redistribution of snow among watersheds. We should also consider whether or not it is necessary to create larger buffers around these habitats.

Let me know if you have any comments.

Thanks again,

Greta

Greta Burkart, PhD
Aquatic Ecologist

US Fish and Wildlife Service
Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
101 12 th Ave Rm 236
Fairbanks, AK 99701
ph: (907) 456-0519
fax: (907) 456-0428
email: greta_burkart@fws.gov
www.facebook.com/arcticnationalwildliferefuge

On Fri, Feb 23, 2018 at 3:49 PM, Churchwell, Roy <roy_churchwell@fws.gov> wrote:

> Hello,
>
> Attached is an exercise I went through. I wanted to know what would be left it a 1/2 mile buffer was put around all of the creeks, rivers, and lakes. You can find a few mistakes in the data along the coast and barrier islands, but you can get an idea of what this looks like. I'm not sure it is realistic at least for every little stream to have a 1/2 mile buffer. Pretty much all of the 1002 is covered. Anyway, I thought I would pass it along.
>
> Roy
>
> --
> Roy Churchwell, PhD
> Wildlife Biologist
> US Fish and Wildlife Service
> Kanuti National Wildlife Refuge
> 101 12th Ave. Room 206
> Fairbanks, AK 99701
> (907) 456-0450
> https://www.fws.gov/refuge/kanuti/

From:	Churchwell, Roy
To:	Fox, Joanna
Subject:	Re: Gear
Date:	Wednesday, February 28, 2018 9:38:51 AM

Thanks!

On Wed, Feb 28, 2018 at 7:20 AM, Fox, Joanna <joanna_fox@fws.gov> wrote:

> Yes Roy - that shouldn't be a problem. I can try to help you find the correct key, but Paul knows a lot more about them than I do.
>
> ___________________________
>
> Joanna L. Fox
> Deputy Refuge Manager
> Arctic National Wildlife Refuge
> 101 12th Avenue, Room 236
> Fairbanks, AK 99701
> (907) 456-0549
>
> Follow us on Facebook!
> www.facebook.com/arcticnationalwildliferefuge
>
> *"Do what you can, with what you have, where you are." -- Theodore Roosevelt*
>
> On Tue, Feb 27, 2018 at 3:02 PM, Churchwell, Roy <roy_churchwell@fws.gov> wrote:
>
>> Hello,
>>
>> Can I get a key to have access to the gear cage in the basement? I need to get a sleeping bag for Laura so she can do the moose survey while I am out in the field doing lynx work.
>>
>> Also, I was wondering if Kanuti Refuge could borrow some cold-weather sleeping bags from Arctic Refuge for going out on the lynx project. I am looking for two sleeping bags for folks on my crew.
>>
>> Thanks for your help.
>>
>> Roy
>>
>> --
>> Roy Churchwell, PhD
>> Wildlife Biologist
>> US Fish and Wildlife Service
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>> 101 12th Ave. Room 206
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--
Roy Churchwell, PhD
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US Fish and Wildlife Service
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(907) 456-0450
https://www.fws.gov/refuge/kanuti/

From: Google Calendar on behalf of Roy Churchwell
To: tina_moran@fws.gov
Subject: New event: 1002 Sensitive Areas @ Fri Mar 2, 2018 10am - 11am (AKST) (roy_churchwell@fws.gov)
Date: Thursday, March 1, 2018 9:46:48 AM

1002 Sensitive Areas

more details »

When Fri Mar 2, 2018 10am – 11am Alaska Time

Video call b5-CIP [redacted]

Calendar roy_churchwell@fws.gov

Who
- roy_churchwell@fws.gov - organizer

From:	Burkart, Greta
To:	Arthur, Stephen
Cc:	Jorgenson, Janet; Churchwell, Roy; Christopher Latty; Leonard, Paul; Joanna Fox; Steve Berendzen; John Trawicki
Subject:	Re: Sensitive areas in 1002
Date:	Friday, March 2, 2018 1:13:00 PM

Hi Everyone,

Here are my additional notes to supplement the maps I sent previously (note most of this was covered in a previous email, but was not received by everyone on the current email list):

I agree that using 0.5 mile buffer for all waterbodies would be more reasonable than approaches previously used by BLM to manage other lands since the original purposes of the Arctic Refuge give it a higher level of protection than BLM managed lands.

I do, however, think we need larger buffers around the high-value habitats that have already been identified: springs and associated features (deep pools, open water, and aufeis), the six known lakes that have sensitive fish species, proposed Wild Rivers (Canning and Hulahula), and the long-term monitoring sites at Jago Bitty, Canning River Delta and Nuvagapak Lagoon. For these high-value areas it would make more sense to use larger buffers and/or the entire upstream watershed. We could also include potential fish-bearing waters as high-value habitats since we do not have adequate data on fish presence to identify high-value habitats. I recently found a dataset of all of the lakes in the Refuge that do not freeze to the bottom (shapefile and report can be accessed here: http://catalog.northslopescience.org/catalog/entries/4782-nssi-lakes-data-mapping-winter-l). Until we have better data on fish distribution, I suggest we consider these lakes to be potentially high-value fish habitat.

Unfortunately, coming up with a way to identify potentially high-value waterbird and invertebrate habitat is much trickier, which is why we should consider identifying highly vulnerable habitats that need special protection. For example, lakes would be particularly vulnerable to water or ice withdrawal if they do not adequately recharge following snowmelt. We can assess a lakes potential to recharge following snowmelt using end-of season snow pack data and an analysis of digital elevation models. If the analysis indicates they a lake is vulnerable to water or ice withdraw, it should get special protection, especially since we lack the information necessary to identify habitat value.

We also need to think about what actions should be taken within different buffers (e.g. no surface disturbance, no permanent infrastructure, no leasing, exclusion from right-of-ways, etc). Below, I have noted selected actions from from the NPRA-EIS, November draft of the CYRMP actions under alternative B, and actions that could help ensure protection of special resource in the Arctic Refuge:

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should be included in the buffer. The following should be completely excluded from the buffer/watershed: surface disturbing activities, surface occupancy, leasing, water/ice withdrawal, and right-of-ways. Subsurface disposal of hazardous wastes is prohibited in the 1002 area because groundwater flowpaths have not been delineated and there could be great potential to have adverse impacts on springs and/or discharge to the Marine Protected Area.

Lentic waterbodies:

- NPR-A: Exploratory drilling prohibited in fish bearing lakes. No permanent facilities within 500-feet of high-water mark. No refueling within 500 feet of the active floodplain of any waterbody. When no fish are present, up to 35% of the total volume can be withdrawn as ice aggregate or water. If sensitive fish are present, 15% of the volume below 7' of ice can be withdrawn as ice aggregate or water. If blackfish or ninespine stickleback are the only fish present 30% of the volume below 5' of ice can be withdrawn.
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Streams, rivers, and floodplains:

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frozen to the substrate. Gravel extraction sites, gravel use sites, and reclamation must be in accordance with a USFWS approved officer and must undergo a thorough NEPA process informed by science that can guarantee with a 95% probability that fish and wildlife habitat will not be impacted. At least ten years of hydrologic data and 30-year climate projections are necessary to develop requirements to ensure adequate fish and surface flow passage in watersheds. Requirements for biological surveys prior to activities??

High-value watersheds:

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Vulnerable lake and stream habitat:

- CYRMP and NPRA EIS: I don't think vulnerable habitats were addressed
- In the Refuge, vulnerable habitats include lakes that may not recharge adequately following removal of ice or water or redistribution of snow by snow fences in nearby watersheds. Anything that alters hydrology supporting vulnerable habitats should be prohibited. This is especially important given that we have very little knowledge of what habitats are of the highest value to fish and waterbirds. Actions would exclude water/ice extraction, gravel extraction, and redistribution of snow among watersheds. We should also consider whether or not it is necessary to create larger buffers around these habitats.

Greta Burkart, PhD
Aquatic Ecologist

US Fish and Wildlife Service
Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
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fax: (907) 456-0428
email: greta_burkart@fws.gov
www.facebook.com/arcticnationalwildliferefuge

On Fri, Mar 2, 2018 at 9:57 AM, Burkart, Greta <greta_burkart@fws.gov> wrote:

> Hi Everyone,
>
> I have attached a map of the following:
>
> - known spring sources (note this does not include the important overwintering habitat and aufeis associated with springs)
> - potential fish habitat (lakes that do not freeze to the bottom)
>
> Additional maps needs to include the following:
>
> - Extent of open water, unfrozen water, and aufeis associated with springs (this would require GIS work to delineate known areas and field work to groundtruth and identify other areas)
> - High-value waterbird habitat (this would require field data)
> - Known fish habitat (would require field studies)
> - Vulnerable habitat (would require GIS analysis and limited field work)
>
> Thanks,
>
> Greta
>
> Greta Burkart, PhD
> Aquatic Ecologist
> US Fish and Wildlife Service
> Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
> 101 12 th Ave Rm 236
> Fairbanks, AK 99701
> ph: (907) 456-0519
> fax: (907) 456-0428
> email: greta_burkart@fws.gov
> www.facebook.com/arcticnationalwildliferefuge
>
> On Wed, Feb 28, 2018 at 4:58 PM, Arthur, Stephen <stephen_arthur@fws.gov> wrote:
>
>> FYI attached is a map showing caribou calving areas (hatched), potential moose habitat (orange shading) and historic locations of muskoxen (blue dots). Adding this to the maps that Roy and Janet have prepared, pretty well covers the area (I'm attaching those maps again because I've added some names to the address list).
>>
>> I'd like for us to convene a brief conference call to discuss how to proceed. Would Friday morning at 10 am (AK time) be acceptable? If not then, please suggest and alternative.

Steve

Stephen M. Arthur, Ph.D.
Supervisory Wildlife Biologist
Arctic National Wildlife Refuge
101 12th Ave., Room 236
Fairbanks, AK 99701
(907)455-1830

On Tue, Feb 27, 2018 at 3:20 PM, Jorgenson, Janet <janet_jorgenson@fws.gov> wrote:

> Attached maps show some sensitive areas, highlighted in red on each map.
>
> The map with the vegetation types highlights the veg type that is the most sensitive to disturbance: Moist sedge-Dryas tundra = moist non-acidic tundra. It has easily damaged vegetation and lots of ice in the near-surface soil, so it often subsides into troughs after being driven on, even in winter. One option would be to designate sensitive area where there is lots of red, like around Niguanak River, Carter Hills and high ridges along Canning and Katakturuk. Note that tussock tundra is shown in yellow and orange, also sensitive but recovers faster.
>
> The salt marsh map shows only the regularly-flooded salt marshes (the kind that have grazing lawns), not the slightly higher areas, so it's too conservative. It can't be compared to salt marsh maps of the rest of the north slope, which were done differently. Map attached here shows just part of the 1002 as an example.
>
> Riparian zones of the main rivers were hand digitized on air photos in 1994.
>
> --
> Janet C. Jorgenson
> Botanist
> Arctic National Wildlife Refuge
> 101 12th Ave, Rm 236
> Fairbanks, Alaska 99701
>
> 907-456-0216

From: Burkart, Greta
To: Christopher Latty
Cc: Steve Berendzen; Joanna Fox; Janet Jorgenson; Roy Churchwell
Subject: Re: some gravel acres numbers
Date: Wednesday, March 7, 2018 2:18:25 PM

Thanks Chris! Do you have the shape or KMZ for alpine developments? IF so, can you point me to the direction where I can find it?

Greta Burkart, PhD
Aquatic Ecologist
US Fish and Wildlife Service
Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
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ph: (907) 456-0519
fax: (907) 456-0428
email: greta_burkart@fws.gov
www.facebook.com/arcticnationalwildliferefuge

On Wed, Mar 7, 2018 at 10:59 AM, Christopher Latty <christopher_latty@fws.gov> wrote:

> Nope- though it would be a quick exercise and Google earth or GIS considering this is just the greater Alpine developments. I'm over at the University at the moment but could do this when I'm back in the office in a half hour or so.
>
> Sent from my iPhone
>
> On Mar 7, 2018, at 10:49 AM, Burkart, Greta <greta_burkart@fws.gov> wrote:
>
> > Thanks Chris,
> >
> > Do you know what the total acreage (developed +undeveloped) is for that area?
> >
> > Greta
> >
> > Greta Burkart, PhD
> > Aquatic Ecologist
> > US Fish and Wildlife Service
> > Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
> > 101 12 th Ave Rm 236
> > Fairbanks, AK 99701
> > ph: (907) 456-0519
> > fax: (907) 456-0428
> > email: greta_burkart@fws.gov
> > www.facebook.com/arcticnationalwildliferefuge
> >
> > On Wed, Mar 7, 2018 at 9:55 AM, Christopher Latty
> > <christopher_latty@fws.gov> wrote:
> >
> > > Hi all

Here are the numbers for gravel on Npra (and adjacent areas) that Debbie Nigro had her GIS person put together. This was just a quick exercise so it should be viewed with some caution and is only meant as an approximate example.

Cheers
Chris

Sent from my iPhone

Begin forwarded message:

> **From:** "Nigro, Debora" <dnigro@blm.gov>
> **Date:** February 27, 2018 at 3:17:33 PM AKST
> **To:** Christopher Latty <christopher_latty@fws.gov>
> **Subject: some gravel acres numbers**
>
> Hi Chris,
>
> Although not all the components are on NPR-A lands they are all part of the same project so I think these numbers are a good idea of what development in the 1002 Area may entail.
>
> For the Alpine satellite development project:
>
> CD- 1,2, 3, 4 ,5:
> pads and airstrips = 123 acres
> roads = 95 acres
>
> GMT-1:
> road and pad = 73 acres
>
> GMT-2:
> road and pad = 78 acres
>
> Gravel mine = at least 125 acres
>
> Total of 494 acres.
>
> In the Alpine satellite development roads are quite short (7 or 8 miles). There is only one airstrip for all the drill pads. Some of the drill pads do not have roads associated with them. I would expect that there would have to be longer roads in the 1002 Area. Not sure what other differences there might be but this is at least a number to think about.
>
> Deb

--
Debbie Nigro
Bureau of Land Management
222 University Ave.
Fairbanks, AK 99709
907-474-2324
dnigro@blm.gov

From:	Trawicki, John
To:	Angela Matz
Subject:	Re: Due March 9th: Review Arctic Refuge 1002 area Resource Assessment Recommended Studies Table
Date:	Wednesday, March 7, 2018 3:32:43 PM

On Mon, Mar 5, 2018 at 10:43 AM, Burkart, Greta <greta_burkart@fws.gov> wrote:

> Hi John,
>
> Give me a call if you want to talk about this exercise. After a quick review, the only changes I came up with are the following:
>
> 1. Rows 8 and 85 are duplicates - remove one of them.
> 2. Row 82 - change purpose to the following: "to understand factors regulating fish and water bird habitat"
> 3. Row 78 (characterize watersheds across the 1002 area in modern geospatial database) -- I think all or most of elements associated with this action are covered under 83. If so, delete this row as a duplicate.
> 4. Row 83 (develop an updated wetlands inventory...) -- Change the following sentence: "*Coupling that with National Hydrologic Database Hydrography mapping is important to understanding the hydrology, especially recharge of lakes and rivers....*" to the following: "*Coupling that with National Hydrologic Database Hydrography mapping is important to understanding the hydrology, especially recharge **and hydrologic connectivity** of lakes and rivers, and habitat..."*
> 5. Row 83 -- It would be great to have ABR and/or ecoscience to conduct vegetation surveys, but at least part of the hyrdologic work could be completed by USFWS staff (e.g. the Arctic Refuge has an underutilized GS-12 aquatic ecologist who is ready and waiting to conduct FY18 work and has been planning lake surveys to assess fish presence, hydrologic connectivity, and contaminants but it is still not clear if this work would be funded. We also have two North Slope fish biologists based at Toolik who are volunteering to assist with fisheries surveys from 22 July to 6 August). Consider changing the following sentence: "FWS would work with BLM and others to define the scope to meet the management needs and then hire a contractor(s) to complete the task as defined" to the following: " F*WS would work with BLM and others to define the scope to meet the management needs and then **FWS and contractor(s) would** complete the task as defined."*
> 6. Row 81 -- Change recommended action to the following: "Conduct inventories to identify fish presence, wetland vegetation, macroinvertebrate diversity, and hydrologic connectivity and develop and validate species occurrence models"
> 7. Row 31 (Fish contaminants) and 81 (Mapping lake biodiversity/habitat/value) should be combined because substantial efficiencies would be gained by doing so. The Arctic Refuge aquatic ecologist has worked with the USFWS contaminant staff and the head of the Alaska Department of Environmental Conservation fish contaminant monitoring program to plan a statistically valid FY18 study to collect fish tissues for baseline contaminant analyses while surveying aquatic habitats. Collecting the additional samples for baseline contaminants assessment would be very low cost. AKDEC is willing to process some of the samples right away. Additional samples could be archived and processed when funding is available.

Greta

Greta Burkart, PhD
Aquatic Ecologist
US Fish and Wildlife Service
Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
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ph: (907) 456-0519
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email: greta_burkart@fws.gov
www.facebook.com/arcticnationalwildliferefuge

---------- Forwarded message ----------
From: **Wendy Loya** <Wendy_loya@fws.gov>
Date: Fri, Mar 2, 2018 at 9:42 PM
Subject: Due March 9th: Review Arctic Refuge 1002 area Resource Assessment Recommended Studies Table
To: Greta Burkart <greta_burkart@fws.gov>, Angela Matz <angela_matz@fws.gov>, Mark Miller <memiller@blm.gov>, Janet Jorgenson <janet_jorgenson@fws.gov>, Randy Brown <randy_j_brown@fws.gov>, Christopher Latty <christopher_latty@fws.gov>, Stephen Arthur <stephen_arthur@fws.gov>, Edward Decleva <edward_decleva@fws.gov>, Tracy Fischbach <tracy_fischbach@fws.gov>, Jennifer Reed <jennifer_reed@fws.gov>, Hollis Twitchell <hollis_twitchell@fws.gov>, Roger Kaye <roger_kaye@fws.gov>
Cc: Drew Crane <drew_crane@fws.gov>, Eric Taylor <eric_taylor@fws.gov>, Joanna Fox <joanna_fox@fws.gov>, John Trawicki <john_trawicki@fws.gov>, Stephanie Brady <stephanie_brady@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, John Martin <john_w_martin@fws.gov>, Paul Leonard <paul_leonard@fws.gov>

Dear Resource Assessment team leads,

We would like to ask your help in the next step of compiling the Arctic Refuge 1002 Area Resource Assessments. Attached is a table that has the recommended studies your assessment identified. Some subjects have been combined.

What I would like to ask you to do is:

1. Review the Purpose, Need and Recommended action and edit as you see fit.

    a. In some instances, we had to do some interpretation or writing to identify the Purpose, Need and Recommended Action.

b. Please refer to the PDF of Table 2.3 of the NPRA EIS for further information on possible lease Stipulations for your subject and adjust the Recommended Action if needed.

You can search the PDF for your keyword (Bird, caribou, air quality, etc) to find the relevant stipulations, focusing on Alt B-2 if differences across Alternatives.

2. Please include a Budget and number of years if you can estimate these, however, not essential at this time.

3. Other columns are locked and cannot be edited. Add

4. If you need to update your Resource Assessment document to add or change anything based on new information, please do so. You can find them in P:\1002ArcticRefuge\1-Working\Resource Assessments Originals (Word not PDF). Please rename your updated Assessment with the current date (e.g. Air Quality 030218). If you don't have access to the drive, please contact IT to have them assign it to your profile.

Please email your updated table to me and Paul Leanard by March 9th, or let us know if you do not plan to make any changes. If you have questions during the week of March 5-9th, please ask Paul. If you are unable to meet this deadline, please let us know.

We will use the table in addition to your Resource Assessment narratives in a compiled document as our initial Science Plan for the 1002 Area; we'll adapt this document as we learn more.

Thank you for your great effort on this,

Sincerely,

Wendy

--
John Trawicki
Water Resources Branch Chief
National Wildlife Refuge System, Alaska
U.S. Fish and Wildlife Service
1011 E. Tudor Road

Anchorage, AK 99503
Work: (907) 786-3474
Mobile: (907) 360-1656

"The single biggest problem with communication is the illusion that it has taken place"
George Bernard Shaw

From:	Churchwell, Roy
To:	Leonard, Paul
Cc:	Christopher Latty
Subject:	Re: Question about R drive
Date:	Thursday, March 8, 2018 7:49:12 PM

Hello,

I am up in Bettles trapping lynx until the end of April, and so I won't be able to work on this yet. I can help out when I get back though.

Roy

On Thu, Mar 8, 2018 at 10:36 AM, Leonard, Paul <paul_leonard@fws.gov> wrote:

> Apparently I need to wait until Hilmar is back in the office to obtain write permissions to this directory: R:\Geodata\Arctic
>
> But in the meantime if one of you would like to create a 1002 directory there and begin posting relevant datasets that would be great.
>
> Otherwise, I'll attempt to set up a structure next week.
>
> Cheers,
> Paul
>
> On Tue, Mar 6, 2018 at 5:20 PM, Churchwell, Roy <roy_churchwell@fws.gov> wrote:
>
>> Hello Paul,
>>
>> If there is 1 TB available on the R: drive then someone must have gone through and cleaned up a bunch of stuff. It was full to capacity the last time I checked in the fall. If there is room, I don't have any issue with using it. I think we all have access to it.
>>
>> Roy
>>
>> On Tue, Mar 6, 2018 at 2:12 PM, Leonard, Paul <paul_leonard@fws.gov> wrote:
>>
>>> You mentioned last friday that the R drive might not be the best location to house the spatial data for 1002 effort. I see it has slightly over 1 TB of space available - is space the only concern you were voicing?
>>>
>>> Since a lot of information is already stored there, I'd like to propose creating a folder specifically for this purpose in hopes of working with all of you to curate information pertinent to the discussion we had last Friday AM. I will use the contents from this to create a database.
>>>
>>> Concerns? My only concern as of now is access - I'm trying to sort that out with Priscilla today.
>>>
>>> Cheers,
>>> Paul

--
Paul Leonard, PhD
Science Coordinator
Arctic LCC
101 12th Ave. Room 216
Fairbanks, AK 99701
(907) 456-0445

--
Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
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https://www.fws.gov/refuge/kanuti/

--
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https://www.fws.gov/refuge/kanuti/

From:	Ahern, Jane
To:	Hollis Twitchell
Subject:	DOI clips
Date:	Friday, March 9, 2018 5:16:25 AM

Not news to you I'm sure;

Trump Official Says Interior Aims To Move 'Pretty Quickly' On Arctic Refuge Oil Development.

KTOO-FM Juneau, AK (3/8, Harball) reports that Interior Deputy Secretary David Bernhardt and Assistant Secretary Joe Balash spoke at an industry gathering in Anchorage "after spending several days in North Slope communities." Bernhardt "said the Trump Administration is working to speed along the process leading to oil development in the Arctic National Wildlife Refuge." He "said in the next few weeks the Interior Department will kick off the regulatory process required before it can hold an oil lease sale in the refuge."

ANWR Development Protesters Gather As Interior Department Officials Visit Fairbanks. The Fairbanks (AK) News-Miner (3/8, Granger) reports that "a group of more than 50 protesters gathered in front of the Noel Wien Public Library Tuesday afternoon to speak out against the continued movement to develop the coastal plain of the Arctic National Wildlife Refuge for oil." The rally was held shortly "after members of the activist group Defend the Sacred learned that Department of Interior officials Deputy Interior Secretary David Bernhardt and Assistant Secretary of the Interior Joe Balash would be visiting Fairbanks to speak with local DOI employees about lease sales in ANWR." Jessica Girard, a spokesperson for Defend the Sacred, said, "There have been really not a lot of notifications from the Department of Interior about their arrival in Alaska. It seems that there will be a big announcement this week about the ANWR and so we're going to stand in solidarity with the Gwich'in people who were not informed of these meetings at all to show that we do not agree with this development and or the expeditious nature of working to get leasing sales before 2020."

The Fairbanks (AK) News-Miner (3/8, Granger) reports that the Interior Department "disputes the claims made by protesters that a Fairbanks meeting between department leaders and employees was a secret meeting about plans to proceed with opening the coastal plain of the Arctic National Wildlife Refuge to oil drilling." Steve Wackowski, senior Interior Department adviser for Alaska Affairs, said, "It wasn't some secret ANWR planning meeting with employees. The topic was 'Meet your department secretary and ask him questions.' We had National Park Service, Office of Aviation Management; folks who had nothing to do with ANWR were in that meeting."

--
Jane Ahern
National Park Service - Northeast Region
Associate Regional Director
External Affairs Office
Phone: 215-597-0865
Cell: 215-817-5870
Check us out at:
www.nps.gov/nero

From:	Twitchell, Hollis
To:	Wendy Loya
Subject:	Re: Due March 9th: Review Arctic Refuge 1002 area Resource Assessment Recommended Studies Table
Date:	Friday, March 9, 2018 5:37:57 PM
Attachments:	1002 Arctic Refuge Resource Assessment Table v.Final Hollis Edits to Subsistence 3-9-18 (2).xlsx

Paul and Windy.

Not certain where to submit edits to priority resource assessments. Attached is the 1002 Excel spread with resource assessments. I put my comments for the Subsistence Resource Assessment in the document bolded in Red color. Recommend the Harvest Monitoring Assessment be funded for 3 years and repeated again after a 5 year break in the monitoring program. Can't afford to do it every year, but there are to many substantial changes occurring in natural environment, weather, abundance or lack of resources geographical, variances in migration patterns and species availability, access or lack of it due to weather and surface conditions, and of course development as a result of seismic, exploration and production infrastructure, etc.

On Fri, Mar 2, 2018 at 9:42 PM, Wendy Loya <Wendy_loya@fws.gov> wrote:

> Dear Resource Assessment team leads,
>
> We would like to ask your help in the next step of compiling the Arctic Refuge 1002 Area Resource Assessments. Attached is a table that has the recommended studies your assessment identified. Some subjects have been combined.
>
> What I would like to ask you to do is:
>
> 1. Review the Purpose, Need and Recommended action and edit as you see fit.
>
>   a. In some instances, we had to do some interpretation or writing to identify the Purpose, Need and Recommended Action.
>
>   b. Please refer to the PDF of Table 2.3 of the NPRA EIS for further information on possible lease Stipulations for your subject and adjust the Recommended Action if needed.
>
>   You can search the PDF for your keyword (Bird, caribou, air quality, etc) to find the relevant stipulations, focusing on Alt B-2 if differences across Alternatives.
>
> 2. Please include a Budget and number of years if you can estimate these, however, not essential at this time.
>
> 3. Other columns are locked and cannot be edited. Add
>
> 4. If you need to update your Resource Assessment document to add or change anything based on new information, please do so. You can find them in P:\1002ArcticRefuge\1-Working\Resource Assessments Originals (Word not PDF). Please rename your updated Assessment with the current date (e.g. Air Quality 030218). If you don't have access to the drive, please contact IT to have them assign it to your profile.

Please email your updated table to me and Paul Leanard by March 9th, or let us know if you do not plan to make any changes. If you have questions during the week of March 5-9th, please ask Paul. If you are unable to meet this deadline, please let us know.

We will use the table in addition to your Resource Assessment narratives in a compiled document as our initial Science Plan for the 1002 Area; we'll adapt this document as we learn more.

Thank you for your great effort on this,

Sincerely,

Wendy

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Air Quality	Compile information needed to develop EIS for 1002 area	Create development scenarios and establish data substitutes in absence of existing monitoring data	Modeling, interpretation, and review could take 1 week to 1 month depending upon the geographic area, nearby sensitive resources, and and impact of operations (e.g., seismic surveys would be much less than a large exploratory drilling rig) and applicability of existing data (satellite data (e.g., validation of NOx plumes from Prudhoe Bay, average patterns of potential pollution ispersion;Limited NOAA/NWS/FAA data; BLM ozone study in NPR-A; Toolik Lake Field Station; Industry-sponsored PM speciation studies at Wainright and Deadhorse). Estimated resources needed to complete this work is one to four technical specialist FTE's from BLM or FWS, all of whom have national-level workloads, and assuming data are sufficient and project is clearly defined.				Pre-Development Baseline	1	1	1	Industry should be reqd to submita plan for approval
Air Quality	Protection of resources during drilling and production	Air Quality (AQ) and Air Quality Related Values (AQRV) analyses will be required for oil and gas exploration and development in the 1002 Area of the Arctic National Wildlife Refuge under Clean Air Act (CAA), National Environmental Protection Act (NEPA), Federal Land Policy Management Act (FLPMA), Refuge Improvement Act and the Wilderness Act, Alaska National Interest Lands Conservation Act (ANILCA), and Arctic NWR Comprehensive Conservation Plan (CCP).	Need to indentify sensitive resources specific to lease area; Specific project development descriptions; likely, additional site-specific AQ and AQRV analyses; further development of near-field Modeling (AERMOD) and far-Field Modeling (North Slope Regional Air Quality Modeling – NS RAQM)				Development (Permanent Infrastructure)	1	1	1	0-Industry does

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Air Quality	Begin monitoring air quality in 1002 area	Air Quality (AQ) and Air Quality Related Values (AQRV) analyses will be required for oil and gas exploration and development in the 1002 Area of the Arctic National Wildlife Refuge under Clean Air Act (CAA), National Environmental Protection Act (NEPA), Federal Land Policy Management Act (FLPMA), Refuge Improvement Act and the Wilderness Act, Alaska National Interest Lands Conservation Act (ANILCA), and Arctic NWR Comprehensive Conservation Plan (CCP).	Establish long-term NAAQS ambient monitoring stations in or near Arctic 1002 area and downwind in sensitive areas, including monitoring and study sites. Per site, equipment and startup costs = $500K and annual costs = $250-300K, depending on location, logistics, and availability of operators.				Pre-Development Baseline	0	1	1	0
Air Quality	Understand natural vs. anthropogenic methane sources	EPA has issued three final rules that together will curb emissions of methane, smog-forming volatile organic compounds (VOCs) and toxic air pollutants such as benzene from new, reconstructed and modified oil and gas sources, while providing greater certainty about Clean Air Act	Establish ethane/methane monitoring station at Toolik and a coastal site (to be determined), which will help in source attribution of methane from industrial activities. The Arctic tundra can be a significant source of methane, so seasonal and interannual variation in baseline emissions is needed.				Pre-Development Baseline	0	1	1	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Air Quality	Determine anticipated future air quality during development and operations	Northern Alaska federal lands such as Arctic NWR and Gates of the Arctic (National Park Service) require quantitative, not qualitative, AQ and AQRV analyses prior to development under NEPA.	Anticipated process for completing NEPA: 1) Ambient air quality data for modeling to determine background AND assessment and tracking of cumulative impacts. There is no ong-term ambient air quality monitoring station data (NAAQS) in or adjacent to the Arctic 1002 area. Collecting sufficient data to inform the NPR-A draft EIS took two years and utilized considerable BLM/FWS staff, significant contractor assistance, and additional agency (EPA) coordination. There is an existing BLM contractor working on the Reasonable Foreseeable Development (RFD) for the Alaska North Slope Air Quality study (NSRAQ study). This work is targeted to be complete by Spring 2019. 2) AQ and AQRV modeling of air quality impacts using Near Field Modeling (AERMOD) and Far-Field Modeling (North Slope Regional Air Quality Modeling – NS RAQM). An estimated $150-200K would be required to to add to the current contract to include the Arctic 1002 project, assuming that it could be modified and a clear funding source is identified. Contract option time frame of 24 to 30 months: initiating and awarding contract (3-4 months); complete contract work (12-15 months); review (3-6 months); incorporating work into NEPA document (3 months).		2		Pre-Development Baseline	1	1	0	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Air Quality	Understand and protect visibility on the north slope	Ensure visibility for communities, aviation/transportation/industrial activities, land management/visitor use.	Establish “Interagency Monitoring of Protected Visual Environments” (IMPROVE) data collection at Toolik Research Station and a coastal site. Equipment cost =$20 - 30K and annual cost per site = $37K (2018 dollars). IMPROVE is an extensive long-term monitoring program to establish the current visibility conditions, track changes in visibility, and determine causal mechanism for the visibility impairment in the National Parks and Wilderness Areas. IMPROVE obtains the necessary air quality, meteorological, and emission data to identify the sources contributing to visibility impairment and their frequency, duration, and contribution to visibility impairment. In addition to source attribution, special studies have been performed to enhance the science of visibility monitoring and learn about aerosol physio-chemical-optical properties. Samplers make measurements of aerosol species, such as ammonium sulfate, ammonium nitrate, total organic carbon, fine soil, and non-soil potassium; light scatter; light extinction; and scenic images.				Pre-Development Baseline	1	0	0	0
All Natural Resources	Extract information from existing technical reports and put into modern geospatial database. Ensure Documents are in a common repository.	Build off the existing science investment to expedite EIS	Cross reference existing technical reports to map any known areas of special values including Wild and Scenic Rivers, springs, subsistence use areas, and recreational areas (e.g. Canning River takeout). Identify data gaps in our knowledge in addition to those mentioned previously. The North Slope Science Inititive (NSSI) catologue would be a possible location for the repository. Funding is for staff time or contractor to design database and compile information.	$30,000	1		Winter Seismic & Explor. Dr	1	0	1	1

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Birds	Develop understanding of waterfowl, loon and shorebird habitats		1) Determine post-breeding abundance, distribution, habitat use, and phenology of waterfowl and loons in lagoons, and of shorebirds in deltas and coastal areas. 2) Investigate how water availability and the patchiness of waterbodies in the 1002 Area affects how disturbance and development may impact birds. Prioritization should be based on species' conservation need and sensitivity to disturbance and development.				EIS Stips and BMPs	0	1	1	0 already generally protected in stips
Birds	Provide contemporary information on distribution and abundance and important habitat areas for birds	To ensure compliance with Migratory Bird Treaty Act and identify important bird habitat to guide stipulations in EIS	Conduct aerial- or ground-based inventories of breeding birds. Species groups should include waterfowl, loons, gulls, shorebirds, and landbirds and should also include both area-wide and site-specific surveys. Prioritization of surveys should be based on conservation needs. Because this information may be important to leasing, and because year-to-year variability will require baseline data to be collected over several years, surveys should begin as soon as possible.	$175,000	3		Winter Seismic & Explor. Dr	0	1	1	1
Birds	Determine use of coastal plain by raptors in late winter	To avoid conflicts between nesting raptors and industrial activities	Conduct aerial- or ground-based inventories of Brooks Range, foothills, and Coastal Plain rivers for breeding cliff-nesting raptors. Because raptors may begin using the Coastal Plain while winter exploration activities occur, these surveys/studies should begin in the near future.				Development (Permanent Infrastructure)	0	1	1	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Birds	Determine pre-development abundance and distribution of predators that prey on birds and eggs	Increased predators, especially fox, are common with infrastructure development	1) Conduct surveys to estimate abundance and distribution of predators of birds and eggs. Additional studies should also be conducted to determine current makeup of nest predators for common or sensitive bird species, and gather baseline information on movement patterns of foxes in the 1002 Area. Because high annual variability will require baseline data to be collected over many years, surveys and studies should begin as soon as practical. 2) Conduct studies on the foraging ecology of nest predators and how individuals choose food items and adjust diet patterns based on alternative prey. Objectives should target ways to inform potential management actions if local predator abundance is found to increase in response to oil and gas related activities.				Pre-Development Baseline	0	0	1	0
Birds	Build a publically accessible database for the long-term dataset for the Canning River Delta tundra nesting bird project	Much of the data from surveys and studies conducted in the 1002 Area are not widely available	The Refuge is working with FWS Science Applications to build a publically accessible database for the long-term dataset for the Canning River Delta tundra nesting bird project. Comparable efforts should follow for other projects to ensure appropriate storage and management of important data and allow for public data access to both contemporary and historical data.				Pre-Development Baseline	1	0	0	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Caribou	Analyze existing telemetry data to quantify seasonal ranges and migration routes	ANILCA, Int'l Agreement for Conservation of Porcupine Caribou Herd	A large database of telemetry data exists that could provide valuable baseline information on caribou movements. These data need to be formally analyzed to update the report "Sensitive Habitats of the Porcupine Caribou Herd" (International Porcupine Caribou Board, 1993); this information is needed to identify sensitive areas that may require special management during development and production. Funding is for time for a wildlife ecologist to analyze data and prepare a report, to be reviewed by wildlife biologists at federal, state and regional agencies.	$50,000	1		EIS Stips and BMPs	1	1	2	1
Caribou	Monitor caribou movement to understand habitat use prior to development	ANILCA, Int'l Agreement for Conservation of Porcupine Caribou Herd	Monitoring data are needed to identify calving areas and seasonal ranges and to quantify caribou recruitment and survival; pre-development data will be used to work with industry to ensure habitat connectivity where possible.	$250,000	5		Pre-Development Baseline	1	1	1	1
Caribou	Establish a Subsistence Harvest Monitoring Program	To ensure long-term conservation of fish and wildlife subsistence species and subsistence uses for qualified subsistence users (ANILCA)	Alaska Department of Fish and Game inermittently interviews year-round households in a community to understand the quantity of subsistence harvest for all natural foods (e.g. fish, land mammals, marine mammals, etc.). A full study has not been done since 1992. In the absence of contemporary information and to understand evolving subsistence harvest, a community supported harvest monitoring program with implementation protocols based on timely and accurate harvest information is needed for communities relying on resources assosiated with the 1002 area, including caribou, fish, furbearers, birds, berries, etc..	$50,000 - $100,000	I		Winter Seismic & Explor. Dr	1	1	1	1

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Caribou	Improve understanding of factors affecting population values and behavior prior to development	The purposes of the Arctic National Wildlife Refuge, as established by the ANILCA include: to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, the Porcupine caribou herd (including participation in coordinated ecological studies and management of this herd …); to fulfill the international fish and wildlife treaty obligations of the United States; to provide the opportunity for continued subsistence uses by local residents. In addition, the International Agreement for the Conservation of the Porcupine Caribou Herd (1987) obligates the governments of the US and Canada to achieve similar goals as stated in ANILCA.	To improve precision of estimates of survival, birth rates, and recruitment so that changes in important demographic parameters can be detected, monitoring intensity should be increased (number of radiocollared caribou and monitoring effort). This monitoring should use GPS collar technology so that fine-scale behavior data can simultaneously be collected, increasing the ability to understand the influence of habitat conditions on demography. Such data would also reveal emigration rates to neighboring herds. Increased field monitoring would also facilitate the following proposed studies (potential cost: $75,000-$100,000 annually)				Pre-Development Baseline	1	1	1	0
Caribou	Assess factors associated with calving site selection	See Above	Identify and evaluate the relative importance of climate, predator abundance, forage quality, insect harassment, population density, and anthropogenic disturbance on calving site selection using a combination of long-term and newly collected data; Estimated cost: $75,000 annually for 5 years. Should be done during exploration period so that impacts of future development can be differentiated from natural drivers.				EIS Stips and BMPs	1	1	1	0

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Caribou	Monitor body condition and survival	ANILCA, Int'l Agreement for Conservation of Porcupine Caribou Herd	Existing long-term monitoring programs should be continued to predict population trends and evaluate the roles of natural vs. anthropogenic factors. These data will be needed to evaluate causes of future changes in population size that are likely to occur during the development and production periods.				Pre-Development Baseline	1	1	0	0
Caribou	Identify drivers of caribou fitness traits (body condition, survival and recruitment)	ANILCA, Int'l Agreement for Conservation of Porcupine Caribou Herd	Use long-term and newly collected data on collared individuals to quantify the effects of annual variation in summer and winter forage conditions (vegetation type, nutritional condition), weather (phenology, snow depth and density, icing events), predator abundance, population density, insect harassment and human activity on caribou body condition, survival and recruitment; Estimated cost: $200,000 annually for 5 years. This information will be needed to differentiate potential effects of displacement from variation due to natural causes, to evaluate mitigation measures that are applied, and to develop improved mitigation strategies.				Pre-Development Baseline	1	1	0	0
Caribou	Monitor body condition and survival	ANILCA, Int'l Agreement for Conservation of Porcupine Caribou Herd	Long-term monitoring of basic physiological and demographic traits is necessary to predict population trends and evaluate the roles of natural vs. anthropogenic factors. These data will be needed to evaluate causes of future changes in population size that are likely to occur during the development and production periods.				Pre-Development Baseline	1	1	0	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Caribou	Investigate characteristics associated with post-calving distribution	ANILCA, Int'l Agreement for Conservation of Porcupine Caribou Herd	Use long-term and newly collected data to understand the influence of weather, forage conditions, insect harassment and population density on caribou movement and resource-selection patterns during the post-calving period. Estimated cost: $150,000 annually for 5 years. This information will be needed during the development phase to guide design and placement of infrastructure.				Pre-Development Baseline	1	0	0	0
Caribou	Project future changes in distribution and demography	ANILCA, Int'l Agreement for Conservation of Porcupine Caribou Herd	With an improved understanding of the factors that influence the behavior and demography of Porcupine caribou (see previous needed studies), the influence of development within the 1002 Area on the herd can be projected, along with expected future changes in other key factors (i.e., climate, insect harassment, forage conditions). Estimated Cost: Analysis time after the other studies have been completed.				Pre-Development Baseline	1	0	0	0
Coastal	Develop a better understanding of coastal and barrier island geomorphology	Understanding the coastline will be important if access to the refuge from offshore ice or waters is desired and to inform erosion modeling.	Obtain more information on coastal and barrier island substrates, including ice content/permafrost, sediment composition, grainsize, etc.. b. Recent observations of brown tundra along coast suggest salt-kill of tundra due to inundation; sometimes recovers when apparently associated with storm surges, but some areas have not recovered since 1970's suggesting subsidence. GPS instrumented monuments across area coast would provide information on changes in elevation, and this could be a component of the BLE LTER monuments if not already. Continue studies to understand evolution and erosion of protective barrier islands (USGS).				Development (Permanent Infrastructure)	1	0	1	0

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Coastal	Contemporary and annually updated understanding of the timing, duration and morphology of nearshore sea ice.	To understand and evaluate both winter and summer coastal access for exploration and development, including sea ice roads and airstrips	The Beaufort Sea Lagoon Long Term Ecological Research site (BLE LTER) funded by NSF will make significant contributions to this topic. FWS, BLM, BOEM and Industry should establish relationships with the researchers and establish data sharing protocols. Agencies or industry may want to partner or use similar methods to expand the monitoring network infrastructure associated with the BLE LTER.				Winter Seismic & Explor. Dr	1	0	0	0
Coastal	Update shoreline erosion rate assessments	Coastal erosion will affect lands available for leasing, infrastructure siting, and potentially access from land to sea and vice versa.	Multiple research efforts are proposed or underway which need continued financial support. Sandia National Laboratories and partners have proposed developing a predictive model of thermos-abrasive erosion for the permafrost Arctic coastline, which will complement efforts by the Beaufort Lagoon Ecosystems LTER (See sec 4. Coastal Habitats) and BOEM's Wave and Hydrodynamic Modeling in the Beaufort Sea (Stefansson Sound). USGS will conduct research on shoreline change in 2018 to understand coastal bluff and beach change.				Development (Permanent Infrastructure)	1	0	0	0
Coastal	To understand seafloor morphology/depth, gravel deposits and identify habitat for coastal species out to approximately 20m water depth.	Identify shipping hazards and resources that could support development and improve understanding of nearshore habitat	Conduct surveys where coastal access is needed for development. Bathymetry was last completed in 1940's. Industry has done work in their areas of interest in the central Beaufort Sea.				Development (Permanent Infrastructure)	0	0	0	0

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Coastal	Establish baseline conditions and monitor change of benthic and water column biota assessments; microbes; fish surveys; community subsistence catch sampling	Impacts of coastal activities, including desalinization/discharge could affect coastal ecosystems, including habitats that Threatened and Endangered Species depend on as well as fish and migratory birds.	Although it will take several years to assemble the baseline, the BLE LTER will make significant contributions to this topic. Study of Fish of nearshore Beaufort Sea planned by USGS in 2018.				Pre-Development Baseline	1	0	0	0
Coastal	Establish baseline conditions and monitor change of coastal/lagoon water quality and chemistry.	Need water quality and sedimentation baselines to understand changes associated with development	Much of this baseline information will be collected as part of the BLE LTER funded by NSF				Pre-Development Baseline	1	0	0	0
Contaminants	Establish baseline of contaminants in sensitive resources	To ensure contiminants of concern are below threshold levels during and after industrial activities in line with ANILCA (continued use of subsistence resources, and quality and quantity of water resources); National Environmental Policy Act (NEPA); Clean Water Act (CWA); Endangered Species Act (ESA); Marine Mammal Protection Act (MMPA)	Develop statistically sound contaminant monitoring program with enough power to detect biologically significant changes in contaminants concentrations, and changes in contaminants concentrations that may exceed regulatory thresholds. Evaluate sampling locations and matrices from previous contaminants baseline study for sufficiency as monitoring sites and matrices, and evaluate current data for suitability as baseline data. Add site-specific monitoring sites and matrices depending upon project description to provide baseline (pre-project) data. For groundwater monitoring, include location, depth, and monitoring interval of groundwater wells that would identify changes from baseline specifically for springs. The USFWS does not currently have sufficient staff with environmental contaminants knowledge and skills to conduct or review studies, or evaluate NEPA documents, for oil and gas exploration or drilling in the 1002 area.				Pre-Development Baseline	0	1	0	Industry must survey

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Contaminants/Fish/Subsistence	Updated baseline sampling in fish, especially those used for subsistence	To ensure contiminants of concern are below threshold levels during and after industrial activities per ANILCA (continued use of subsistence resources)	Updated baseline sampling in fish, especially those used for subsistence, of contaminants associated with oil and gas development including heavy metals, persistent organics, NORMs, and hydrocarbons.				Pre-Development Baseline	0	1	0	Industry must survey
Contaminants/Migratory Birds/Subsistence	Updated baseline contaminant exposure information for birds breeding in the 1002 area	To ensure contiminants of concern are below threshold levels during and after industrial activities per ANILCA (continued use of subsistence resources)	Updated baseline contaminant exposure information for birds breeding in the 1002 area, and those using deltas and lagoons for fall staging, with particular emphasis on hydrocarbon and heavy metal exposure, and how contaminant burdens may affect subsistence value.				Pre-Development Baseline	0	1	0	Industry must survey if subsistence
Contaminants/Polar Bears	Updated baseline contaminant exposure information for polar bears in the 1002 area	To ensure contiminants of concern are below threshold levels during and after industrial activities per ESA and MMPA	Continued collection of polar bear contaminants exposure data, with an emphasis on hydrocarbon and heavy metal exposure				Pre-Development Baseline	0	1	0	Industry must survey
Cultural	Identification of cultural resource sites and their signifance	Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of its actions (in this case permitting oil and gas exploration and extraction) on historic properties (defined as prehistoric and historic objects, features, structures, sites, and districts).	Cultural resource investigations will be necessary to sufficiently identify cultural resource sites, determine the significance of such sites, to evaluate effects to sites determined eligible under National Register of Historic Places criteria, and to determine avoidance, minimization and mitigation standards for eligible sites that would be adversely affected by oil and gas activities. USFWS should commit one full-time GS-0193-11 archeologist to oversee agency cultural resource investigation permitting and Section 106 responsibilities during the duration of oil and gas exploration and extraction operations development.				Pre-Development Baseline	0	1	1	0-Recommended position

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Noise	Wildlife, Subsistence user and visitor disturbance-response information	To support impact analyses and mitigation requirements for noise attenuation in subsistence, visitor use and senstive wildlife areas.	Although much general information is available, specific disturbance-response information is needed to quantitatively or qualitatively characterize relationships between noise metrics and response metrics for noise-sensitive resources including wildlife (especially caribou and polar bears), residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness.				Pre-Development Baseline	1	0	1	0
Noise	Quantify acoustic characteristics of specific development-related noise sources	To support impact analyses and mitigation requirements for noise attenuation in subsistence, visitor use and senstive wildlife areas.	Although some general acoustic information is available, impact assessment and mitigation actions would benefit from specific acoustic information associated with specific development activities that are anticipated or proposed for the 1002 Area. Such information is analogous to emissions inventory data.				Pre-Development Baseline	1	0	0	0
Noise	Establish baseline acoustic conditions	To support impact mitigation and adaptive management.	Baseline acoustic data for the 1002 Area are completely lacking, with the exception of short-term data collected in the extreme northwest corner of 1002 Area in support of the Point Thomson EIS (USACE 2012).				Pre-Development Baseline	0	0	0	0
Noise	Modeled spatial predictions of acoustic impacts	To support impact mitigation and adaptive management.	Spatial noise propagation modeling that specifically applies to anticipated / proposed development activities and specific landscape characteristics and seasonal atmospheric conditions.				Pre-Development Baseline	0	0	0	0

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Noise	Establish long-term acoustic monitoring	To determine the efficacy of BMPs designed to minimize effects of low-flying aircraft on should be designed and implemented by BLM or USFWS staff (or appropriate cooperators / contractors) with expertise on the topics of acoustic engineering and environmental monitoring. This should be done in close collaboration with subject matter experts for specific noise-sensitive resources. As noted above, long-term acoustic monitoring (or the lack thereof) in NPR-A has potential implications for development planning and impact mitigation in the 1002 Area.	A long term acoustic monitoring program should be designed and implemented by BLM or USFWS staff (or appropriate cooperators / contractors) with expertise on the topics of acoustic engineering and environmental monitoring. This should be done in close collaboration with subject matter experts for specific noise-sensitive resources. As noted above, long-term acoustic monitoring (or the lack thereof) in NPR-A has potential implications for development planning and impact mitigation in the 1002 Area.				Pre-Development Baseline	0	0	0	0
Oil Spills	Establish baseline data in a scientifically and statistically sound manner to evaluate effects of oil spills on sensitive resources	To ensure compliance with Oil Pollution Act (OPA), including Natural Resource Damage Assessment and Restoration (NRDAR); Endangered Species Act (ESA); Marine Mammal Protection Act (MMPA); National Environmental Policy Act (NEPA)	Compile NRDA pre-assessement data on biological and other trust resources in geospatial database, including: Aquatic habitats: shorelines, near-shore marine, rivers, lakes, groundwater, springs; Terrestrial habitats: soil, vegetation; Species groups: Birds (waterfowl, shorebirds, raptors), including eiders listed under the ESA; Fish - freshwater and anadromous; Polar bears - listed under the ESA and the MMPA; Terrestrial mammals including caribou, muskox, grizzly bears; Fish, wildlife, and vegetation used for subsistence.				Pre-Development Baseline	1	1	0	0

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Oil Spills	Prepare information needed for spill response	To ensure compliance with Oil Pollution Act (OPA), including Natural Resource Damage Assessment and Restoration (NRDAR); Endangered Species Act (ESA); Marine Mammal Protection Act (MMPA); National Environmental Policy Act (NEPA)	National and statewide oil spill planning tools exist and can be updated (e.g., shoreline Environmental Sensitivity Index (ESI) Maps; NOAA's Arctic Environmental Response Management Application or ERMA: https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma/arctic-erma.html). These tools inform oil spill planning and response; those for the 1002 area, especially inland, may need updating. Identify shoreline segments for Shoreline Classification and Assessment Techniques (a spill response technique), based off existing information in ShoreZone, USGS open file reports and other coastal information resources.				Development (Permanent Infrastructure)	1	1	0	0
Other Mammals	Improved undertanding of the abundance and distribution of grizzly bears; the relative importance of the 1002 area as denning habitat is unknown	This baseline information will be needed to assess potential effects of future development.	Estimate abundance of grizzly bears in the 1002 Area during June. Estimated cost: $100,000 during one year, or $50,000 per year for 2 years.				Pre-Development Baseline	0	1	1	0
Other Mammals	Improved undertanding of the distribution and abundance of wolves and wolverines; to document den site locations and habitat attributes; evaluate potential for disturbance or mortality related to interaction with human activities; and evaluate effects of increased access by subsistence hunters and trappers.	To identify and reduce disturbance to wolf denning habitat	Revisit wolf dens documented during the 1980s to see if any are still being used and identify any new den sites. Wolf observations during seasonal surveys for ungulates would provide some indication of wolf packs that occupy the 1002 area. Estimated cost: $10,000. Wolf dens are thought to be rare within the 1002 Area; however, any that are found should be flagged for special management consideration.				Pre-Development Baseline	1	1	0	0

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Other Mammals	Improved undertanding of the distribution and abundance of wolves and wolverines; to document den site locations and habitat attributes; evaluate potential for disturbance or mortality related to interaction with human activities; and evaluate effects of increased access by subsistence hunters and trappers.	To identify and reduce disturbance to wolf denning habitat	Record observations of wolverines and their tracks during late winter surveys for ungulates to obtain information on relative abundance and distribution. Potential denning habitats of wolverines with kits should be mapped using satellite imagery or other methods. (No cost other than staff time, assuming ungulate surveys are funded). Surveys should begin prior to development to provide baseline information.				Pre-Development Baseline	1	1	0	0
Other Mammals	Improvied understanding of moose and muskox populations	These ongoing surveys are needed to assess responses of these species to human activities and habitat changes.	Continue annual surveys for moose and muskoxen that systematically cover the 1002 area in late winter. Estimated cost: $10,000 per year.				Pre-Development Baseline	1	1	0	0
Other Mammals	Improved understanding of furbearer abundance and distribution	This information will be used to guide design and siting of future infrastructure.	Record observations of wolves and wolverines and their tracks during seasonal surveys for ungulates to obtain information on relative abundance and distribution. An inventory of known dens should be established. (No cost other than staff time, assuming ungulate surveys are funded).				Pre-Development Baseline	1	1	0	0

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Other Mammals	More information is needed regarding how predation, weather, disease, and nutrition influence population dynamics of moose and muskoxen; the potential for reestablishment of muskoxen in the Refuge by expansion of neighboring populations; and the potential effects of human activities (positive: protection from predators; or negative: disturbance or displacement) on both species	Study should begin prior to development to provide baseline information on this population.	Investigate the relationship between climate change, vegetation, and moose population dynamics. Could be built into ongoing monitoring work; primary cost would be additional staff time for data analysis plus ~$10,000 per year for browse surveys. These data are needed to differentiate between natural and anthropogenic effects on moose populations.				Pre-Development Baseline	1	1	0	0
Other Mammals	Improved understanding of lemming cycles and theirrelationship to shorebird and fox populations	These data are needed to distinguish between natural and anthropogenic effects.	Conduct long-term monitoring of relative abundance of foxes and lemmings, and their effects on nesting birds; Estimated cost: $20,000 annually, in collaboration with shorebird and waterfowl monitoring. These data are needed to distinguish between natural and anthropogenic effects.				Pre-Development Baseline	1	1	0	0
Other Mammals	Understanding grizzly bear abundance and distribution across refuge	This information is needed to monitor effectiveness of established mitigation measures and to ensure human safety.	1) Identify locations of dens; estimate population size at 5-year intervals. 2)Monitor occurrence and behavior of grizzly bears in relation to human activities; . Estimated cost: $30,000 per year plus $100,000 every 5 years.				Pre-Development Baseline	0	1	0	0

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Other Mammals	We need a greater understanding of predator/prey and competitive relationships among red and arctic foxes, lemmings, and ground-nesting birds; how these are affected by lemming cycles; and how these complex relationships may be altered by anthropogenic disturbance.	The purposes of the Arctic National Wildlife Refuge, as established by the ANILCA include: to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, …, grizzly bears, muskox, Dall sheep, wolves, [and] wolverines, …; and to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents	Develop methods to estimate abundance of fox and lemming populations; monitor changes over time; and assess impacts on nesting birds. Estimated cost: $70,000 annually for 3 years to develop and verify techniques. This information will be needed to distinguish between natural influences and potential effects of future development, and to assist with the design and siting of future infrastructure.				Pre-Development Baseline	0	1	0	0
Other Mammals	Improved understanding of ecosystem interactions regulating moose populations	These data are needed to differentiate between natural and anthropogenic effects on moose populations.	Continue investigation of the relationship between climate, vegetation, and moose population dynamics. Could be built into ongoing monitoring work; primary cost would be additional staff time for data analysis plus ~$10,000 per year for browse surveys.				Pre-Development Baseline	1	0	0	0
Other Mammals	Improved understanding of habitat use requirements for large herbivores	This information will be needed to assess long-term impacts of development and to distinguish those from effects of natural processes.	Develop protocols for long-term monitoring of habitat characteristics important to large herbivores, including vegetation type, nutrient quality, snow characteristics (depth, density, extent, phenology, icing events). Initial costs would be limited to additional staff time; future costs to be determined.				Pre-Development Baseline	1	0	0	0
Other Mammals	Expand knowledge of which mammal species are present on the coastal plain; information is particularly needed for little-known species and those whose ranges are restricted to arctic tundra	This information is needed to understand how diversity of species is changing	Monitor observations of hares and their tracks to detect potential range expansion; determine species identity of hares that are observed. (No cost except staff time to compile and verify observations).				Pre-Development Baseline	1	0	0	0

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Paleontological	Identification of paleontological resources within the 1002 area	The Paleontological Resources Preservation Act (PRPA) of 2009 requires the Secretary of the Interior to manage and protect paleontological resources on Federal lands using scientific principles and expertise.	Paleontological resource investigations, can likely be conducted concurrent with cultural resource investigations to sufficiently identify Pleistocene Epoch paleontological resources (e.g. mammoth, steppe bison, horse and other Ice Age mammal fossils) that may be located at the surface to determine avoidance, minimization and mitigation standards.				Pre-Development Baseline	0	1	0	0
Permafrost/Active Layer	Develop model that relates active layer depth to vegetation and soils	Depth of active layer and seasonal dates of soil freezing and thaw are important in permitting winter exploration activities so that they have minimal impact on plants and soils	Using existing monitoring data and suplementing with additional field measurements, create a model that links vegetation, soils and active layer/permafrost dynamics to project landscape conditions for the 1002 area to facilitate winter transportation permitting.				Winter Seismic & Explor. Dr	1	0	0	0
Polar Bears	Identification of possible methods to avoid overlap and interactions between polar bears and Industry activities, and to reduce the potential for interactions	to achieve a small numbers determination and reach a negligible impact determination (MMPA) as well as avoid jeopardy and adverse modification or destruction of critical habitat (ESA)	1) Comprehensive Review of Management Measures (e.g., season/area restrictions, den buffer zones, facility location/design). 2) Avoidance: Examine available data to identify areas of particularly high use or biological importance for seasonal or year round avoidance areas. 3) Develop new mitigation measures specific to the unique characteristics of the 1002 area to reduce the number of bears taken and the overall impact of Industry.				Winter Seismic & Explor. Dr	1	1	1	PB
Polar Bears	To understand th availablity of polar bears for subsistence use and ensure information exchange between communities, managers and industry	To avoid impacts to subsistence hunting	Periodically assess key community perspectives, values and needs regarding human-polar bear interactions and sustainable use of polar bears for subsistence purposes.				Winter Seismic & Explor. Dr	1	0	1	0

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Polar Bears	To explain current habitat use patterns	To improve polar bear detection and provide guidance to industry in meeting requirements under MMPA/ESA	Continue, expand, and improve den detection, mapping, and monitoring activities to understand why there is higher use of habitat within the 1002 area and greater reproductive success for land-based dens. Identify movement and land use patterns of polar bears in the 1002 area;	2018: $220K; 2019-on: $360K	>5		Winter Seismic & Explor. Dr	1	1	0	PB
Polar Bears	An accurate and current understanding of the population dynamics of the Southern Beaufort Sea subpopulation of polar bears is needed in order to estimate the impact of anticipated take (i.e. to determine small numbers and make negligible impact determinations under MMPA and jeopardy determinations under ESA)	Understanding population dynamics is needed in order to estimate the impact of anticipated take (i.e. to determine small numbers and make negligible impact determinations under MMPA and jeopardy determinations under ESA)	1) Estimation of abundance and population dynamics (i.e. demographic rates such as survival and reproduction). Surveys using mark-recapture methods are a more viable option than other non-invasive techniques . 2) Continue to evaluate emerging technologies (e.g., high-resolution satellite imagery, GPS collar reliability, collar drop off mechanism performance) for integration into existing monitoring plans.(e.g., aerial survey).	2018: $450K ; 2019-on: $2.5million	>5		Winter Seismic & Explor. Dr	1	1	0	PB
Polar Bears	To understand the potential spatial and temporal overlap between polar bears and oil and gas development and the factors influencing the likelihood and consequences of interactions between polar bears and those development activities	To determine the number of polar bears likely to be taken (small numbers determination under MMPA) and the consequences of that take to the individual animal and ultimately the stock (negligible impact determination under MMPA) and to the species (jeopardy determination under ESA)	1) Use existing movement data to look at relationships with existing infrastructure (does it appear bears are avoiding those areas and if so what is the impact zone). 2) Monitor for potential disturbances at den sites.				Winter Seismic & Explor. Dr	1	1	0	0

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Polar Bears	To make future predictions on how distribution and movement is likely to respond to predicted sea ice loss and other habitat changes.	This understanding is needed in order to predict how many and how animals are likely to be impacted by proposed activities (small numbers and negligible impact determination under MMPA) and whether proposed actions are likely to adversely modify or destroy designated critical habitat (ESA determination).	Use projected changes due to sea ice loss, especially given the increased proportion of the population coming on shore in that region. Identify potential for habitat use and behavioral patterns to be modified due to increased human activities.				Winter Seismic & Explor. Drilling	1	0	0	0
Public Health	To understand the benefits and impacts of oil and gas exploration and development on communities in and around the 1002 area of the Arctic National Wildlife Refuge	Requirement or standard practice for Northslope EIS	The Liberty Draft EIS and Point Thompson Final EIS both include Health Impact Assessments for Kaktovik that may be further evaluated for site specific and cumulative effects for Kaktovik as well as other communities in or adjacent to the refuge (Arctic Village, Venetie) or those that rely on natural resources from the Refuge. Health Impact Assessments should include evaluaiton of: Social Determinants of Health; Accidents and Injuries; Exposure to Potentially Hazardous Materials; Food, Nutrition, and Subsistence Activity; Infectious Disease; Water and Sanitation; Non-communicable and Chronic Diseases; and Health Services Infrastructure and Capacity. Funding request woudl be to secure a contractor to complete Health Impact Assessments.	$50-$100K	1		EIS Stips and BMPs	1	0	1	1

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Snow/Weather	Create and/or Evaluate Snow Distribution Models to capture snow depth across the 1002 Area	To be able to identify annually snow drifts with highest probability to create potential polar bear denning habitat (MMPA/ESA). To establish minimum snow required for winter tundra travel to protect taller stature vegetation in 1002 area during exploration and development.	Snow depth and drifting monitoring and calibration of snow model for 1002 area. A combination of snow, wind and temperature monitoring stations and ground surveys, as well as high-resolution digital elevation models will be necessary to create a more accurate snow model for the 1002 area. UAF has received funding from NASA to collect aircraft-based imagery of snow levels in April 2018, and funding is needed for fuel, lodging and ground truthing by snowmachine surveys. This would provide a preliminary baseline for snow depth in polar bear denning habitat and for winter tundra travel. Continued operation of 3 remote meterological stations provides continuous temperature, wind and precipitation (including snow). Addition of 2-3 NRCS run SNOTEL sites would improve spatial coverage ($13k annual / $24-30k installation per site - estimates from SNOTEL (NRCS contribution possible)). This information, coupled with requested vegetation map and high resolution topography (DEM) map would be used to plan future monitoring and aerial imagery aquisition to inform an improved snow model based off the SnowDens 3D Model developed by Dr. Glen Liston through a previous NFWF grant.	2018: $40K;$30-100k SNOTEL initiation (NRCS contribution would decrease)/ $13k per annum SNOTEL operation	1+		Winter Seismic & Explor. Drilling	1	1	1	1
Snow/Weather	Compile new and historical information on archaeological, ethnographic and subsistence work that has been completed for Arctic Refuge's 1002 area in a database and ensure associated documents are catalogued.	To provide information needed EIS and for Sec 810 analysis.	Create a functional repository and database of existing contemporary and historical data. Multiple sources of published and unpublished subsistence use and harvest data reside with various agencies, organizations, tribal governments, and universities. The North Slope Science Inititive (NSSI) catologue would be a possible location for the repository. Funding is for staff time or contractor to design database and compile information.	$50,000	1		Winter Seismic & Explor. Dr	1	0	1	1

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Snow/Weather	Characterize seasonality in water quantity and quality in primary rivers of 1002 area.	Understanding river flow is needed to inform transportation planning and water withdrawal permitting, and is therefore part of the EIS	Conduct continuous water quality and quantity monitoring on the Hulahula, Tamayariak, and Canning rivers to evaluate the current status and natural variability in late fall and spring surface water quality and quantity in relation to the timing of fish use and industrial activity. Compile information in a database that will be used for permitting and impacts analyses.	$175,000	5		Winter Seismic & Explor. Dr	1	0	1	1
Soil Temperatures	Determine trends in soil temperatures across 1002 area	Soils must be sufficiently frozen to reduce damage to soils including rutting, erosion from Low-Ground Pressure Vehicles associated with exploration, development	Active layer/permafrost depth can be monitored with sensors (in assocation with remote weather stations such as DOI/GTN-P sites), but will also need to be measured with ground surveys across different ecosystem types in areas of proposed activity due to variation across the area. Recommend funding existing and expanded network of meteorological stations including soil temperature thermistors located after data analyses and/or field surveys to capture sites representative of east to west and north to south differences in meteorology (temperatures) and soils.				Winter Seismic & Explor. Drilling	1	0	0	0
Soils	Characterize soil types in 1002 area	A finer-scale soil map is needed to understand variation in soil structure and freezing patterns to support winter exploration as well as to understand factors affecting infrastructure placement such as wetlands, hydrology and permafrost.	Soil surveys will need to be produced at a finer spatial resolution than is currently available (1:1,000,000). Recommend completeing a level 3 soil survey for the area (1:63,000), followed by level 2 by companies at development sites and along corridors. Completing a survey would inform distribution of soils, permafrost, wetlands, and vegetation communities. Conducting a survey across the 1002 would likely take 3 to 4 years and ~$1 to $1.5 million to complete. This includes staff time and field equipment. It could be completed faster but the cost would increase significantly (~3 to 7 million dollars depending if contracted or not) and the final product would likely be of poorer quality.				Pre-Development Baseline	0	0	0	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Subsistence	Compile new and historical information on archaeological, ethnographic and subsistence work that has been completed for Arctic Refuge's 1002 area in a database and ensure associated documents are catalogued.	To provide information needed EIS and for Sec 810 analysis.	Create a functional repository and database of existing contemporary and historical data. Multiple sources of published and unpublished subsistence use and harvest data reside with various agencies, organizations, tribal governments, and universities. The North Slope Science Initive (NSSI) catologue would be a possible location for the repository. Funding is for staff time or contractor to design database and compile information.	$50,000	1		EIS Stips and BMPs	1	0	1	1
Subsistence	Establish a Subsistence Harvest Monitoring Program	To ensure long-term conservation of fish and wildlife subsistence species and subsistence uses for qualified subsistence users (ANILCA)	Alaska Department of Fish and Game inermittently interviews year-round households in a community to understand the quantity of subsistence harvest for all natural foods (e.g. fish, land mammals, marine mammals, etc.). A full study has not been done since 1992. In the absence of contemporary information and to understand evolving subsistence harvest, a community supported harvest monitoring program with implementation protocols based on timely and accurate harvest information is needed for communities relying on resources assosiated with the 1002 area, including caribou, fish, furbearers, birds, berries, etc..	$50,000 - $100,000 ($75000 + $75000 = $75000)	I (3)	Windy, Paul: This project should be funded for 3 years: 1 to establish monitoring program and implement; 2nd and 3rd years conducting monitoring program. There's to great a variance in seasonal availability of resources, changing weather and access varibles, and unpredictable changes in migrations routes and patterns. Ideally, this 3 year monitoring program should be repeated at least every decade, and if possible every 5 years. 5 year break between	Pre-Development Baseline	1	1	1	1

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Subsistence	Compile existing cultural work (Subsistence, historical, archaeological)	To meet the requirements of ANILCA and International Treaties, ensure protection of cultural resources	A limited number of archeological and historical resource surveys have taken place on the Refuge due to funding, logistical difficulties of working in remote locations and lack of infrastructure to support investigations in the Refuge. A more through and complete synthesis of what work has been completed and in what areas would help identify informational gaps and help set priorities for future work.				EIS Stips and BMPs	1	1	0	0
Subsistence	Gather Oral Histories and Traditional Knowledge Study to guide management	To benefit historical site protection and guide management decisions and guide setting priorities for surveys and research in the 1002 area	Much valuable cultural, historic, and traditional ecological knowledge about the Refuge and the coastal plain (1002 area) is possessed by local elders. Oral histories and place names contain an enormous amount of information on traditional uses, culturally important places, historic camps and settlements, and other natural and cultural information.				Pre-Development Baseline	0	0	0	0
Subsistence	Establish the economic value of caribou to subsistence users	To meet the requirements of ANILCA and International Treaties	Quantify the economic value of caribou and other subsistence harvest resources.				EIS Stips and BMPs	0	0	0	0
Vegetation	Evaluate efficacy of current BMPs in protecting vegetation and soils during seismic	Protecting vegatation and soils is required by BMPs but it is unclear what the standards should be for the varied terrain in the 1002 area	Review existing studies of impacts and recovery from from seismic exploration currently occurring on North Slope, including information in the grey literature of Alaska DNR, BLM, NSB and others if existing and available.				Development (Permanent Infrastructure)	1	0	0	Req by industry

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Visitor Use	To evaluate, and possibly minimize, the effects of oil and gas development and infrastructure upon visitors, and commercial operators that support those visitors.	The Coastal Plain of the Arctic National Wildlife Refuge has been identified by visitors as important for experiencing Wilderness, Vastness, Remoteness and Isolation, A Sense of Adventure and Natural Conditions (Christensen & Christensen 2009), so evaluating impacts to the view- and sound-scapes will likely be requested during scoping for NEPA.	Baseline studies are needed to evaluate the natural view and soundscapes. Viewscape baseline study, including visible pollution plumes and infrastructure changes to existing undeveloped viewshed. Night sky baseline study to document auroral, stargazing, and other astronomical resource conditions and potential future changes to existing night sky opportunities. Soundscape baseline study to document auditory resource conditions and potential future changes to existing natural sound environment.				Pre-Development Baseline	0	0	1	0
Visitor Use	Characterize visitor expectations	The Coastal Plain of the Arctic National Wildlife Refuge has been identified by visitors as important for experiencing Wilderness, Vastness, Remoteness and Isolation, A Sense of Adventure and Natural Conditions (Christensen & Christensen 2009), so evaluating impacts to the view- and sound-scapes will likely be requested during scoping for NEPA.	● Evaluate existing OMB-approved FWS visitor surveys for generalized information about Alaska Region's visitation patterns and preferences (duration: XX; lead: Natalie Sexton/Debbie Steen?; cost: XX). ● Re-evaluate 2009 visitor survey data held by Neal Christensen, to identify any possible additional information about experience condition expectations of visitors, specific to the Coastal Plain (duration: 3 months after contracted; lead: Jen Reed?; cost estimate: $10K?) ● Repeat/focus Arctic Refuge Visitor Survey to obtain current data about expectations of visitors, specific to the Coastal Plain (warning: dependent upon OMB approval) (duration: lead: XX, cost estimate: XX). ● Evaluate Refuge's raw 2010-2011 Client Use Report (CUR) data, consistent with previous data, to identify additional information specific to the Coastal Plain; and of Refuge's limited 2012-2017 CUR data (reporting requirements inconsistent with previous data). (duration of effort: 6 months; lead: Reed; cost estimate: $3K for contracted database support)				Pre-Development Baseline	1	0	0	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Water	Characterize seasonality in water quantity and quality in primary rivers of 1002 area.	Understanding river flow is needed to inform transportation planning and water withdrawal permitting, and is therefore part of the EIS	Conduct continuous water quality and quantity monitoring on the Hulahula, Tamayariak, and Canning rivers to evaluate the current status and natural variability in late fall and spring surface water quality and quantity in relation to the timing of fish use and industrial activity. Compile information in a database that will be used for permitting and impacts analyses.	$175,000	5		Pre-Development Baseline	1	0	1	1
Water	Evaluate efficacy of current BMPs in NPRA and applicability to 1002 area for protecting aquatic habitat	Ensure that protective measures put in place achieve desired results and warrant science-investment by agencies, industry	Compare the quality of aquatic habitat by conducting surveys of macroinvertebrates, wet meadow zones, recharge rates, and winter water quality in the NPR-A on untapped lakes and lakes where the entire permitted volume has been withdrawn and the vulnerability is similar to a range of lake types in the coastal plain 1002 area (FY18-19 costs: $80,000, potential leads: BLM, USFWS, USGS).				Development (Permanent Infrastructure)	1	0	0	0
Water	Characterize watersheds across 1002 area in modern geospatial database	To inform transportation planing, water withdrawal permitting, and evantually infrastructure planning	Develop geospatial inventory of hydrologic connectivity, watershed areas and relative snowpack to assess lake vulnerability/recharge potential (FY18-20, leads: USGS, USFWS)				Pre-Development Baseline	0	0	0	0
Water/Contaminants	Develop an integrated understanding of surface and groundwater	To inform transportation planing, water withdrawal permitting, and evantually infrastructure planning	Evaluate surface (including springs) and groundwater flow paths and recharge; develop conceptual groundwater model informed by isotopic studies to delineate and age flow paths. Quantify river recharge rates to inform water withdrawal permits. (FY18-20 total cost: $$, potential leads: USGS and USFWS). In subsequent years, develop geospatial inventory of hydrologic connectivity, watershed areas and relative snowpack to assess lake vulnerability/recharge potential (FY18-20, leads: USGS, USFWS)				Pre-Development Baseline	0	0	1	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Water/Fish	Characterize the contribution of aufeis (sheet-like mass of ice that forms from successive ground water flow during freezing temperatures) to river flow and habitat.	To inform transportation planing, water withdrawal permitting, and evantually infrastructure planning	Identify aufeis-associated fish habitat and evaluate terrestrial mammal use of aufeis, aufeis contributions to late summer flows, and the importance of aufeis and ice-dam flooding in recharging fish and wildlife habitat in the Canning, Hulahula, Itkilyariak, Katakturak, and Sadlerochit river drainages (FY18/19 costs: $, USFWS and USGS).				Pre-Development Baseline	0	0	1	0
Water/Fish	Identify fish and wildlife habitat associated with lakes	To inform transportation planing, water withdrawal permitting, and evantually infrastructure planning	Conduct inventories to identify: fish presence, high-quality waterbird habitat, macroinvertebrate diversity (FY18-20, lead: USFWS)				Winter Seismic & Explor. Drilling	0	0	0	Industry must survey
Water/Fish	To understand factors regulating fish habitat	To inform transportation planing, water withdrawal permitting, and evantually infrastructure planning	Continuous water level and winter water quality monitoring on representative lakes to evaluate current status and natural variability relative to timing of potential impacts of industrial activities and use by fish and wildlife (FY18-22, leads: USFWS, USGS, BLM).				Pre-Development Baseline	0	0	0	0

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Water/Wetlands/Vegetation	Develop an updated Wetlands Inventory Map, including watershed map, and a Vegetation Map	To permit and/or guide seismic, tundra travel, water/snow use and infrastructure planning	There is significant efficiency and cost savings in the coordinated development of a Wetland Map with associated hydrography, and a vegetation map, as much of the cost is associated with field work to validate the classifications. The 1002 area needs an updated Wetlands Inventory that our Ecological Services division uses in every BLM or Corp of Engineers project. Coupling that with National Hydrologic Database Hydrography mapping is important to understanding the hydrology, especially recharge of lakes and rivers, and habitat in the 1002 area which is very different than NPRA. An accurate, updated vegetation map is essential for working with Industry to permit seismic and winter tundra travel, as the vegetation of the 1002 area is much taller than in NPRA, including large areas of tussock tundra which is highly susceptible to damage. When NSSI updated the North Slope Vegetation Map in collaboration with Ducks Unlimited, the 1002 area was not field-validated and is therefore lower accuracy and thus insufficient to meet planningl needs. FWS would work with BLM and others to define the scope to meet the management needs and then hire a contractor(s) to complete the task as defined. Timeline to completion is approximaely 1.5 to 2 years. Cost estimate would cover all work.	$350K - $450K	1		EIS Stips and BMPs	1	2	1	1

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Water/Wetlands/Vegetation	To understand the benefits and impacts of oil and gas exploration and development on communities in and around the 1002 area of the Arctic National Wildlife Refuge	Requirement or standard practice for Northslope EIS	The Liberty Draft EIS and Point Thompson Final EIS both include Health Impact Assessments for Kaktovik that may be further evaluated for site specific and cumulative effects for Kaktovik as well as other communities in or adjacent to the refuge (Arctic Village, Venetie) or those that rely on natural resources from the Refuge. Health Impact Assessments should include evaluaiton of: Social Determinants of Health; Accidents and Injuries; Exposure to Potentially Hazardous Materials; Food, Nutrition, and Subsistence Activity; Infectious Disease; Water and Sanitation; Non-communicable and Chronic Diseases; and Health Services Infrastructure and Capacity. Funding request woudl be to secure a contractor to complete Health Impact Assessments.	$50-$100K	1		Winter Seismic & Explor. Dr	1	0	1	1
Water/Wetlands/Vegetation	Extract information from existing technical reports and put into modern geospatial database. Ensure Documents are in a common repository.	Build off the existing science investment to expedite EIS	Cross reference existing technical reports to map any known areas of special values including Wild and Scenic Rivers, springs, subsistence use areas, and recreational areas (e.g. Canning River takeout). Identify data gaps in our knowledge in addition to those mentioned previously. The North Slope Science Inititive (NSSI) catologue would be a possible location for the repository. Funding is for staff time or contractor to design database and compile information.	$30,000	1		Winter Seismic & Explor. Dr	1	0	1	1

Resource	Purpose	Need	Recommended Action	Projected Annual Cost	Number of years (Use 6 if >5)	Comments	First Stage needed (dropdown list)	Does this build off existing efforts?	Regulatory	Needed to Inform Selection of Stips and ROPs	Notes
Wetlands	Create an updated wetlands map to provide guidance to industry and land managers	Section 404 - establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands	An updated wetlands map at 1:24,000 scale is needed to identify wetlands and hydrographic relationships. Recent acquisition of IFSAR imagery and proposed LiDAR acquisition by the North Slope Borough to USGS could contripute to improved landform and hyrologic mapping needed for a wetlands map. Completion of a map could take approximately 18 months, building off existing field survey efforts of vegetation (FWS); desktop modeling from imagery for water flow and preliminary wetlands classification based off existing ortho-imagery; a season of field validation followed by final map development and review.				Development (Permanent Infrastructure)	0	1	0	0
							EIS Stips and BMPs				
							Winter Seismic & Explor. Drilling				
							Pre-Development Baseline				
							Development (Permanent Infrastructure)				

From:	Twitchell, Hollis
To:	Leonard, Paul; Wendy Loya; Steve Berendzen
Subject:	Re: Follow up from Friday
Date:	Monday, March 12, 2018 3:19:42 PM
Attachments:	1002 Arctic Refuge Resource Assessment Table v.Final Hollis Edits to Subsistence 3-9-18 (2).xlsx (attachment available on p. 445)

Hi Paul, sorry I forgot to attach you name on my comments and edits to the Subsistence Resource assessment last Friday. This is what I sent to Wendy, My comments and recommendations are in red color in the comment column of the spread sheet.

Here's what I sent to Wendy:

Paul and Windy.

Not certain where to submit edits to priority resource assessments. Attached is the 1002 Excel spread with resource assessments. I put my comments for the Subsistence Resource Assessment in the document bolded in Red color. Recommend the Harvest Monitoring Assessment be funded for 3 years and repeated again after a 5 year break in the monitoring program. Can't afford to do it every year, but there are to many substantial changes occurring in natural environment, weather, abundance or lack of resources geographical, variances in migration patterns and species availability, access or lack of it due to weather and surface conditions, and of course development as a result of seismic, exploration and production infrastructure, etc.

On Mon, Mar 12, 2018 at 12:21 PM, Leonard, Paul <paul_leonard@fws.gov> wrote:

> Hi Hollis,
>
> Just wanted to circle back with you and ask if you had any additional questions about the process we discussed on Friday or if you need anything else from me to submit your edits?
>
> Cheers,
> Paul
>
> --
> Paul Leonard, PhD
> Science Coordinator
> Arctic LCC
> 101 12th Ave. Room 216
> Fairbanks, AK 99701
> (907) 456-0445

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From: Fritz, Stacey
To: David Fauske; Sondra Leavitt; Frederick Brower, Ex. Dir.
Cc: Hollis Twitchell
Subject: Disregard my call about potential meeting Tuesday March 27th, it has been cancelled
Date: Tuesday, March 13, 2018 4:08:17 PM

Frederick, David, and Sondra, hello,

Please disregard my calls trying to schedule a meeting about the 1002 leasing plan - those meetings have been cancelled.

Thank you so much for your patience. We anticipate setting up scoping meetings in late April / early May and the BLM/USFWS will likely be sending out invitations to consult before then.

Best,

--

Stacey Fritz
Anthropologist/Subsistence Specialist
BLM Arctic District Office
222 University Ave.
Fairbanks, AK, 99709
fax: (907) 474-2282
work phone: (907) 474-2309
cell phone: (907) 687-6549

From:	Berendzen, Steve
To:	Stephen Arthur; Christopher Latty; Greta Burkart; Jorgenson, Janet; Roy Churchwell; Roger Kaye; Reed, Jennifer; Hollis Twitchell; Joanna Fox; Tina Moran
Subject:	Fwd: Notice of request from your staff: Bios for Arctic Refuge 1002 EIS
Date:	Friday, March 16, 2018 11:28:07 AM

A heads up that it's not determined for sure if the EIS will be contracted to a private consultant, or if it will be done in house by BLM and FWS. This is the best info on a timeline which is important for scheduling if we end up writing our portions of the document. This will be a priority :)

Steve Berendzen
Refuge Manager, Arctic National Wildlife Refuge
907-456-0253

---------- Forwarded message ----------
From: **Wendy Loya** <Wendy_loya@fws.gov>
Date: Fri, Mar 16, 2018 at 9:06 AM
Subject: Notice of request from your staff: Bios for Arctic Refuge 1002 EIS
To: Mary Colligan <mary_colligan@fws.gov>, Socheata Lor <socheata_lor@fws.gov>, Doug Damberg <doug_damberg@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, Joanna Fox <joanna_fox@fws.gov>, Thomas Doolittle <thomas_doolittle@fws.gov>, Eric Taylor <eric_taylor@fws.gov>, Sarena Selbo <sarena_selbo@fws.gov>
Cc: Greg Siekaniec <greg_siekaniec@fws.gov>, Karen Clark <karen_clark@fws.gov>

Dear FWS Colleagues,

Shortly I will be sending out a request for a ½ page Bio to those on your staff that have been identified as potential writers/or reviewers for the “Coastal Plain EIS” at the request of DOI leadership. Below are the staff that you all have identified. BLM Alaska anticipates that the NOI will go out next week (Week of March 19th), which would start the 1 year clock for the EIS (which will meet the 300 page guidelines).

FWS staff selected by DOI to participate should be prepared to receive further information shortly thereafter about their roles and the timeline. There will be 2 months of scoping (approximately mid-March through mid-May) then preparation of the Draft EIS might continue through mid-September. This is all subject to change as we adapt to assist meeting the 1 year timeline. Although not given direction yet, I would guess that FWS will play a role in describing the affected environment.

As decisions are made by DOI on who is selected to be on the team, I will keep you updated; we will share a list of staff engaged publically when decisions are made. Staff identified from BLM also going through this process. Please contact me with any questions and I will do my best to answer them.

DRAFT list of potential FWS writers and/or reviewers for Coastal Plain EIS:

Job Title	FWS
Technical editor/writer	
International Liaison	Charlie Hamilton (Polar Bears)
Geologist/Petroleum Engineer	BLM
	BLM
	BLM
	FWS
Soil Scientist	Greta Burkhart
Botanist	Janet Jorgenson
Hydrologist	Greta Burkhart, Paul Leonard
Soil Scientist/Hydrologist	Janet Jorgenson
Archaeologist	Ed Declava (Likely need BLM or contractor)
Wildland Fire Specialist	Peter Butteri
Air Resource Specialist	Greta Burkhart
Physical Scientist	
Fish Biologist	Randy Brown
Wildlife Biologist (Birds)	Christopher Latty, Eric Taylor, Rick Lanctot, Jim Johnson, Steve Lewis, Michael Swaim, Julian Fischer, Ted Swem
Wildlife Biologist (Marine Mammals)	Ryan Wilson (Polar bears)
Wildlife Biologist (Terrestrial Mammals)	Steve Arthur
Lands/Realty Specialist	Hollis Twitchell; Eva Patton; Carl Johnson, Robbin LaVine
Economist	
Lands/Realty Specialist	Susan Lakomski
Transportation/VRM	
Recreation	Jennifer Reed
Public Health Scientist	
Hazardous Materials Specialist	Angela Matz
Wilderness Values	Roger Kaye
GIS/Mapping	
Cumulative Effects, Impact assessments	John Martin

Wendy

Dr. Wendy M. Loya,

Arctic Program Coordinator, Office of Science Applications

US Fish and Wildlife Service

Anchorage, Alaska

907.786.3532 (office)

907.227.2942 (mobile)

From: Twitchell, Hollis
To: Wendy Loya
Subject: Re: Due 3/19 10am Arctic Refuge 1002 EIS: Request for potential author/reviewer info
Date: Friday, March 16, 2018 1:12:40 PM

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1. Name: Hollis Twitchell

2. Agency: FWS

3. Job Title: Assistant Manager

4. Area of Expertise: Cultural, Subsistence, Tribal Relations

5. Education: Natural Resource Management, Aviation Technology

6. Years and type of experience: 10 years Lake Clark National Park (Pilot Park Ranger LE to Chief of Natural Resources to Chief Ranger), 15 years Denali National Park (Chief of Subsistence and Cultural Resources), 3 years Yukon Delta National Wildlife Refuge (Assistant Manager), 9 years Arctic National Wildlife Refuge (Assistant Manager). Little bit of everything.

On Fri, Mar 16, 2018 at 9:08 AM, Wendy Loya <Wendy_loya@fws.gov> wrote:

> Dear FWS Colleagues,
>
> You have been identified as a potential writer and/or reviewer for the Arctic Refuge 1002 Area "Coastal Plain EIS." BLM has requested information on all DOI employees that have been identified by their agency. Please see the request below, and provide me your ½ page max response in Word, to be forwarded to BLM Alaska and then shared upwards in DOI. Please contact me or your supervisor if you have any questions.
>
> **Please provide a response BY 10am March 19th.**
>
> We are in the process of developing a dedicated interdisciplinary team to support the development of the Coastal Plain Leasing EIS. Your name was given as a subject matter expert for one or more areas in the Coastal Plain Leasing EIS. So that we may ensure we are allocating our resources as efficiently as possible and pairing the correct personnel with the correct resources, please provide a short bio using the template below. Limit this to no more than one-half page.
>
> 1. Name
>
> 2. Agency
>
> 3. Job Title
>
> 4. Area of Expertise

5. Education: *any post-secondary degrees*

6. Years and type of experience: *Please include most relevant large projects you have worked on and role; and most relevant documents you have authored or published; etc.*

Thank you!

Wendy

Dr. Wendy M. Loya,

Arctic Program Coordinator, Office of Science Applications

US Fish and Wildlife Service

Anchorage, Alaska

907.786.3532 (office)

907.227.2942 (mobile)

--

Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From: Burkart, Greta
To: Stephen Arthur; Christopher Latty; Janet Jorgenson; Roy Churchwell; Joanna Fox; John Trawicki; Paul Leonard; Steve Berendzen
Subject: Re: Ideas for Arctic Refuge-NOAA collaborations needed by Friday 23 March
Date: Friday, March 23, 2018 4:17:34 PM

Hi Everyone,

I submitted ideas for Arctic Refuge (see below) If you would like to make any additions to this list, please add them to the following google document by 5pm today: https://docs google com/spreadsheets/d/1-kU3k6rKF4HRKbDYiCrBwPvY4j7U2CUY9Soj4kEOICM/edit#gid=0

Thanks,

Greta

Alaska flooding processes are dominated by ice jam events during breakup. Ice jams are vital for recharge of floodplain lakes, transport nutrients across the floodplain, and are a vital form of disturbance in maintaining a mosaic of habitats for multiple species. Changes in climate may result in fundamental changes in the processes that maintain these habitats. Currently we do not have a record of ice jams throughout the interior riverscapes and the only reliable records of ice jams are from village locations in years that ice jams cause local flooding. Identification of historic ice jam events and complete mapping of future ice jams will assist in furthering our understanding of lanscape processes and understand changes in the future. FWS does not have the expertise to analyze historic or future SAR data. This has been identified as a need for multiple refuges, including Kanuti, Yukon Flats, Togiak, and Arctic.	Develop understanding of landscape processes and changes in those processes in the future
Along wi h identifying ice jams, determining the inundated area from flooding events is needed as well. Current and future planned lauches of satellites would allow for remotely sensed assessment of inundated areas to better determine landscapes reliant on flooding processes. This has been identified as a need for multiple refuges, including Kanuti, Yukon Flats, Togiak, and Arctic.	Determine inundated area during flood events
Rain on snow events can significant impacts on terrestrial wildlife. Developing geospatial products depicting the extent and severity of these events would provide wildlife biologists and managers with information to further their understanding of populaiton dynamics and may assist with adjustments to harvest levels in areas affected by rain on snow events. This has been identified as a need for multiple refuges, including Kanuti, Yukon Flats, Selawik, and Arctic.	Develop geospatial products identifying areas affected by rain on snow events for each year.
Geospatial data products hat include phenology of ice (ice-off and onset of ice formation) and snow.	Assess impacts of climate change and provide guidance for field surveys that rely on the many aquatic and terrestrial surveys that rely on this information.
A Climate Reference Network station on the North Slope of the Arctic Refuge	Provides data for understanding climate change and can provide important explanatory variables for understanding the dynamics of the Refuge's trust resources.

Greta Burkart, PhD
Aquatic Ecologist
US Fish and Wildlife Service
Arctic National Wildlife Refuge and Alaska Refuges Inventory and Monitoring Program
101 12 th Ave Rm 236
Fairbanks, AK 99701
ph: (907) 456-0519
fax: (907) 456-0428
email: greta_burkart@fws gov
www facebook com/arcticnationalwildliferefuge

On Fri, Mar 23, 2018 at 10:27 AM, Burkart, Greta <greta_burkart@fws gov> wrote:

> Hi Everyone,
>
> To see what kind of ideas NOAA is looking for, I thought I would share some examples that others have presented for the following (see more details in the table below):
>
> - improve simulation models to predict fate and effects of oil spill in different seasons
> - geospatial products depicting the extent and severity of rain on snow events
> - identify historic ice-jam flooding events and determine area inundated
> - acquire information (e g freeze-thaw cycles) and use modeling to come up with better estimates, stipulations, and best management plans for reducing impacts on tundra during winter travel
> - Climate data and modeling expertise from NWS could be combined with nest timing data from FWS to allow for annual prediction of timing of nest site initiation This would help determine timing of surveys
> - High definition satellite imagery to identify bird concentration areas
>
> If you support the development of these ideas or have any additional ideas, let me know by 5pm today
>
> Thanks,

Greta

Greta Burkart, PhD
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On Thu, Mar 22, 2018 at 12:40 PM, Burkart, Greta <greta_burkart@fws gov> wrote:

Hi Everyone -- I am just checking in to see if Alaska Maritime has any climate related needs that they would like addressed by NOAA. If you can, please send information by tomorrow.

Thanks,

Greta

Greta Burkart, PhD
Aquatic Ecologist
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www facebook com/arcticnationalwildliferefuge

On Mon, Mar 19, 2018 at 8:18 AM, Burkart, Greta <greta_burkart@fws gov> wrote:

Hi Everyone,

Diane Granfors asked me to contact Arctic Refuge staff and others to get potential ideas for how Arctic Refuge can collaborate with NWS-NOAA to help meet management needs. The ideas/needs will be compiled with those of other refuges and submitted to NOAA who will decide which potential collaborations/ modeling projects they would like to move forward on. Can you please send your ideas/needs to me in the following template **by Friday, 23 March**:

- Brief description of FWS need:
- Management application:
- Need time-frame (urgent: 2-6 months, 6-12 months, or 12+ months)
- FWS employee name:
- Contact information:

NWS-NOAA is specifically interested in what tools they can provide us to use NOAA data products. One of their questions to USFWS was "if you had better predictive information what would you do with it?" The mission of this effort is to provide integrated environmental analysis and forecasts while collaborating with partners to enable better decision making and preparedness For more information on this effort, check out the NWS- Alaska Region presentation.

Examples of ideas from other refuges and Migratory Birds Management are provided below.

Thanks,

Greta

Examples of needs for other Refuges and Migratory Bird Management Program:

Brief description of FWS need (and potential NOAA connections, if known)	Management application	Decision timeframe (2-6 months; 6 - 12 months, 12 + months)
Priority interest in completion of Climate Reference Stations. Interest in weather data as it relates to phenology (e.g., ice breakup and bird arrival timings).	Winter severity index to inform large mammal harvest management	12+ months
The Migratory Bird Program is responsible for monitoring waterfowl abundance relative to established thresholds that indicate when harvest should be liberalized or restricted. Such harvest management decisions rely on accurate and unbiased estimates of population size, but aerial breeding pair survey results can be biased if data collection does not coincide with initiation of nesting. Date of nest initiation is affected by timing of spring temperatures and snow melt. With a warming variable climate it is necessary to adjust survey timing annually based on models that link spring conditions to nest initiation. Climate data and modeling expertise from NWS should be combined with nest timing data from FWS to allow for annual prediction of initiation.	Select the best harvest strategy based on improved estimates of abundance that account for survey timing relative to nest initiation.	12+ months
One of the greatest risks to Alaska breeding seabirds is the threat of oil spills in the marine environment. The Migratory Bird Program is responsible for mapping distributions of seabirds, but the intersection of their bird distributions and movements of potential spilled oil is less known. Simulation models are needed to predict the fate and effects of oil spills of various sizes and during different times of year in order to plan for and prioritize cleanup efforts in order to reduce direct loss of seabirds due to fouling of feathers and indirect loss through contamination of their prey base.	Develop pre-spill contingency plans	12+ months

Greta Burkart, PhD
Aquatic Ecologist
US Fish and Wildlife Service

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www.facebook.com/arcticnationalwildliferefuge

Brief description of FWS need (and potential NOAA connections, if known)	Management application	Decision timeframe (2-6 months; 6 - 12 months, 12 + months)	sorting categories	FWS employee Name	Contact information	FWS Program
USFWS activites in Alaska are highly dependent on aviation, particularly small aircraft that operate under Visual Flight Rules. Safety of these operations has increased with growth of the network of webcams linked to the FAA. Continued coordination between NWS and FAA to broaden the network of aviation webcams will increase aviation safety for USFWS pilots and personnel.	Increase safety of USFWS Aviation Program	12+ months. Long-term	aviation webcams	Nate Olson	Nathan_Olson@fws.gov	RAM
Bathymetric mapping of Selawik Lake and Hotham Inlet	Facilitates the exploration of critical habitat of subsistence species [e.g. Sheefish (Inconnu) and Whitefish (Coregonid sp.)] and their forage fish species [e.g. herring and smelt].	12+ months, Long-term	Bathymetry	Bill Carter	bill_carter@fws.gov	NWRS
Geospatial data products that include phenology of ice (ice-off and onset of ice formation) and snow.	Assess impacts of climate change and provide guidance for field surveys that rely on the many aquatic and terrestrial surveys that rely on this information.	12+ months, Long-term	climate change modeling	Greta Burkart	greta_burkart@fws.gov	NWRS
Model changes in aquatic temperature from climate data.	Facilitate long term planning and understanding of availabiity of aquatic habitats across Refuges and the State	12+ months, Long-term	climate models	Meg Perdue	maragret_perdue@fws.gov	NWRS
Provide models for predcting change in stream flow of annual hydrographs across Alaska. Instrested in predicting changes in timing, duration, and magnitude of seasonal flow events that characterize the rivers in different regions of the State.	Provides a means for understanding future changes in streamflow that will affect habitat availability, stream temperature, and water availability across refuges	12+ months, Long-term	climate projections	Cathy Flanagan	cathleen_flanagan@fws.gov	NWRS
A Climate Reference Network station on the North Slope of the Arctic Refuge	Provides data for understanding climate change and can provide important explanatory variables for understanding the dynamics of the Refuge's trust resources.	12+ months, Long-term	Climate station	Greta Burkart	greta_burkart@fws.gov	NWRS
Per the Migratory Bird Treaty Act, as amended, subsistence harvest of birds and eggs is closed for 30 days during the primary nesting period. The specific closure period varies by region and is based on available average nest initiation information. Shifts in timing of spring are expected to impact dates of nest initiation rendering historical average nesting dates inaccurate. To improve the effectiveness of the 30-day closure for conservation of nesting birds a predictive model is needed to correlate spring conditions with timing of nesting throughout the state. Climate data and modeling expertise from NWS should be combined with nest timing data from FWS to allow for annual prediction of initiation of nesting based on spring conditions.	Refine timing of the migratory bird subsistence harvest closure period using annual spring climatic conditions.	12+ months. Decision is made annually, by region, refinements could be applied in future years	clmate modeling link to surveys and harvest	Julian Fischer	Julian_Fischer@fws.gov	MBM

The Migratory Bird Program is responsible for monitoring waterfowl abundance relative to established thresholds that indicate when harvest should be liberalized or restricted. Such harvest management decisions rely on accurate and unbiased estimates of population size, but aerial breeding pair survey results can be biased if data collection does not coincide with initiation of nesting. Date of nest initiation is affected by timing of spring temperatures and snow melt. With a warming variable climate it is necessary to adjust survey timing annually based on models that link spring conditions to nest initation. Climate data and modeling expertise from NWS should be combined with nest timing data from FWS to allow for annual prediction of initiation.	Select the best harvest strategy based on improved estimates of abundance that account for survey timing relative to nest initiation.	12+ months. Harvest strategies are updated annually	clmate modeling link to surveys and harvest	Julian Fischer	Julian_Fischer@fws.gov	MBM
The Migratory Bird Program monitors seabird distribution, abundance and trends throughout marine waters in Alaska, but the causes for observed changes are not well understood. The dependence of seabirds on plankton and fish prey makes the opportunity for collaboration with NOAA highly valuable. Easy accessibility to data on plankton and fish data would allow USFWS biologists understand and predict changes to seabird populations.	Determine environmental and biological drivers of seabird distribution, abundance, and trends.	12+ months. Ongoing research needs	Data accessibility	Kathy Kuletz	Kathy_Kuletz@fws.gov	MBM
Create a more inclusive (all weather stations) for one stop shopping of weather data with a standardized .csv outputs	Inclusion of air temperature, precipitaiton, precipitation as snow into other databases for stream gage analysis	12+ months, Long-term	Data accessibility	Wayne Stanislowski	wayne_stanislowski@fws.gov	NWRS
Provide better models and data products for predicting rain as snow.	Provides an understanding of rain versus snow patterns across a basin for understanding long term effects on hydrologic flow patterns	12+ months, Long-term	Data accessibility	Cathy Flanagan	cathleen_flanagan@fws.gov	NWRS
Provide water balance tools for selected basins across Alaska.	Provides a means of understanding water availability over time.	12+ months, Long-term	data accessibility	Jasper Hardison	jasper_hardison@fws.gov	NWRS
There has been a lot of recent work on the Y-K Delta but little synthesis of information in a manner that can be used to support FWS and/or Regional Planning. NOAA has programs that provide decision support tools in coastal regions around the country, can these tools be provided for the Y-K Delta region? Sea level rise, river and coastal erosion, changes in snow and freeze-up/thaw patterns, changes in available water, are all important considerations for managing resources as well as for the communities on the delta.	Can help support the NWR I&M program, the regional planning effort "Adapt Y-K Delta" and many community-level needs.	short-mid term depending on key use. Adapt Y-K Delta is underway now.	data accessibility	Karen Murphy	karen_a_murphy@fws.gov	
To reduce damage to sensitive tundra habitat, movement of oil and gas drilling supplies and construction of drill pads is generally completed during the frozen period. Stipulations for timing of these activities should be based on habitat conditions rather than fixed calandar dates. Collaboration with NWS would provide guidance on annual flucutations in freeze and thaw cycles which in turn will guide development of best management practices for activities that may affect tundra habitats.	Development of oil and gas development stipulations based on annual timing of freeze and thaw on the North Slope	6-12 months. Development of stipulations for leasing of the 10-02 area is on fast track.	freeze thaw cycles in arctic	FES?	?	FES
Northern, Western, and Interior Alaska flooding processes are dominated by ice jam events during breakup. Ice jams are vital for recharge of floodplain lakes, transport nutrients across the floodplain, and are a vital form of disturbance in maintaining a mosaic of habitats for multiple species. Changes in climate may result in fundamental changes in the processes that maintain these habitats. Currently we do not have a record of ice jams throughout the interior riverscapes and the only reliable records of ice jams are from village locations in years that ice jams cause local flooding. Identification of historic ice jam events and complete mapping of future ice jams will assist in furthering our understanding of lanscape processes and understand changes in the future. FWS does not have the expertise to analyze historic or future SAR data. This has been identified as a need for multiple refuges, including Kanuti, Yukon Flats, Togiak, and Arctic.	Develop understanding of landscape processes and changes in those processes in the future	12+ months, Long-term	ice jam - historic analysis and future mapping	Joshua Rose and Greta Burkart	joshua_rose@fws.gov and greta_burkart@fws.gov	NWRS
Along with identifying ice jams, determining the inundated area from flooding events is needed as well. Current and future planned lauches of satellites would allow for remotely sensed assessment of inundated areas to better determine landscapes reliant on flooding processes. This has been identified as a need for multiple refuges, including Kanuti, Yukon Flats, Togiak, and Arctic.	Determine inundated area during flood events	12+ months, Long-term	ice jams and corresponding inundation areas	Joshua Rose and Greta Burkart	joshua_rose@fws.gov and greta_burkart@fws.gov	NWRS

One of the greatest risks to Alaska breeding seabirds is the threat of oil spills in the marine environment. The Migratory Bird Program is responsible for mapping distributions of seabirds, but the intersection of their bird distributions and movements of potential spilled oil is less known. Simulation models are needed to predict the fate and effects of oil spills of various sizes and during different times of year in order to plan for and prioritize cleanup efforts in order to reduce direct loss of seabirds due to fouling of feathers and indirect loss through contamination of their prey base.	Develop pre-spill contingency plans	12+ months. Spill contingency plans updated periodically	oil spill simulation models to connect to bird distributions/use	Kathy Kuletz	Kathy_Kuletz@fws.gov	MBM
Models of permafrost change	Facilitation an understanding of long term change in surface water patterns and habitat availability on the landscape	12+ months, Long-term	permafrost	Meg Perdue	maragret_perdue@fws.gov	NWRS
A photographic survey of the world's population of Spectacled Eiders will be conducted in March 2019 (and pending funding availability, repeated in March 2020) in the northern Bering Sea. There, eiders concentrate in open water leads surrounded by sea ice. The location and size of open water leads will be needed to determine the appropriate location to conduct the photographic survey.	Estimate the world population size of Spectacled Eider for incorporation in the Species Status Assessment	6-12 months. Aerial photographic surveys to be completed in March 2019 and 2020	polyngna identification and description	Dan Rizzolo	daniel_rizzolo@fws.gov	FES
Rain on snow events can significant impacts on terrestrial wildlife. Developing geospatial products depicting the extent and severity of these events would provide wildlife biologists and managers with information to further their understanding of populaiton dynamics and may assist with adjustments to harvest levels in areas affected by rain on snow events. This has been identified as a need for multiple refuges, including Kanuti, Yukon Flats, Selawik, and Arctic.	Develop geospatial products identifying areas affected by rain on snow events for each year.	12+ months, Long-term	rain on snow	Joshua Rose and Greta Burkart	joshua_rose@fws.gov and greta_burkart@fws.gov	NWRS
If NOAA has capacity to generate ultra high definition satellite imagery, this data could be used to estimate flock sizes of migratory birds during spring, fall, and winter staging. Harvest regulations of some species are based on abundance derived from staging surveys. Identification of bird concentration areas could also be used in oil spill contingency planning.	Harvest management and oil spill contingency planning	12+ months. Harvest strategies are updated annually	remote sensing bird populations	Julian Fischer	Julian_Fischer@fws.gov	MBM
Spectacled Eiders are an ice-dependent species that rely on sea ice with open water leads juxtoposed with abundance of highly nutritious clams in the Bering Sea. Ice serves as important roosting habitat for the eiders between foraging bouts. Changes in the distribution of winter ice is expected to have consequences for over-winter survival of this ESA-listed species. Collaboration with NWS on determinig timing, distribution, and density of ice in the northern Bering Sea will provide FWS with information needed to evaluate changes in Spectacled Eider populations on the breeding grounds where their population size is monitored. These results will be used to evaluate the continued viability of the species in a changing climate.	Incorporate risk of changes in winter habitat quality into Species Status Assessment for Spectacled Eiders	12+ months. Species Status Assessment to be completed within ~2 years	sea ice projections	Kate Martin	Kate_Martin@fws.gov/	FES
Models for predicting snowcover extent and snow water equivalant by basin	Provides an understanding of water availalbe for surface water contribution (and ground water contribution in conjunction with permafrost modeling).	12+ months, Long-term	weather data	Jasper Hardison	jasper_hardison@fws.gov	NWRS
Development of spill trajectories in a reactive mode to help inform response activities and also in a proactive mode to help position equipment	Increases our ability to respond successfully to spills to minimize impacts to trust resources	Short and long term		Mary Colligan	mary_colligan@fws.gov	FES
Ice and weather forecasts to predict movement of polar bears and walrus to be able to inform management and research actions including timing and location of field work, subsistence hunting activities and human-polar bear and human-walrus overlap	Help predict accessiblity of animals for subsistence hunting (and associated level of take), help direct management efforts to greatest areas of overlap between polar bears and humans (deterrence training) and walrus and humans (haul out management)	short and long term		Mary Colligan	mary_colligan@fws.gov	FES

Consideration of river and ocean temperature and currents to be able to predict timing of Pacific salmon runs (in-migrating adults) as well as smolt outmigration	Help direct timing of monitoring efforts in the field as well as management of the fishery	short and long term		Mary Colligan	mary_colligan@fws.gov	FES
Priority interest in completion of Climate Reference Stations. Data will be used to inform phenology study on berries (an important resource for bears) and compliment regional lake temperature monitoring stations that are used by ADF&G and Refuge to assess salmon habitat conditions under changing climate conditions. Climate data for southern Kodiak Island currently is lacking.	Temperature and precip data from planned Climate Reference Station will aid study of phenology monitoring of forage resources (berries and salmon) for Kodiak bear.	12+ months		Bill Pyle	bill_pyle@fws.gov	NWRS
Priority interest in completion of Climate Reference Stations. Interest in weather data as it relates to phenology (e.g., ice breakup and bird arrival timings).	Winter severity index to inform large mammal harvest management	12+ months		Brad Scotton	brad_scotton@fws.gov	NWRS
Connecting river extreme event information (both floods and drought) to fish passage structures. How do we know that new or rehabilitated sites will still function in extreme conditions?	Assist in the design or new and/or restored fish passage sites.	long term		Mike Daigneault (entered by K. Murphy)	Mike_Daigneault@fws.gov	FES

Cell: B1
Comment: Sarena thinks we can just delete this column.
-Karen Murphy

Urgent (2-6 months)
Urgent (2-6 months)
Urgent (2-6 months)

From:	Berendzen, Steve
To:	Hollis Twitchell
Cc:	Joanna Fox
Subject:	Fwd: FW: Consultation with Tribes, Corporations on 1002
Date:	Friday, March 23, 2018 5:13:21 PM

Hollis,

Heads up that you need to attend this meeting next week Tuesday at 2:00 if possible. Your calendar doesn't indicate that you'll be out that day.

Steve Berendzen
Refuge Manager, Arctic National Wildlife Refuge
907-456-0253

---------- Forwarded message ----------
From: **Wendy Loya** <Wendy_loya@fws.gov>
Date: Fri, Mar 23, 2018 at 3:02 PM
Subject: FW: Consultation with Tribes, Corporations on 1002
To: Steve Berendzen <steve_berendzen@fws.gov>, Joanna Fox <joanna_fox@fws.gov>

Hi Steve and Joanna,

Nicole at BLM would like to talk with you and Hollis next week during our regularly scheduled FWS-BLM Weekly Check-in on Coastal Plain 1002 from 2-3pm. Can you see if Hollis is available to attend in order to find out what BLM would like FWS to do with regards to preliminary outreach to communities? Also, want to make sure both or one of you two were available for this conversation. There are of course details I can't capture and correctly convey, so I have asked that we discuss this on Tuesday with BLM directly.

Thanks!

Wendy

Dr. Wendy M. Loya, Coordinator

Office of Science Applications -Arctic Program

US Fish and Wildlife Service

Anchorage, Alaska

907.786.3532 (office)

907.277.2942 (mobile)

From: Hayes, Miriam (Nicole) [mailto:mnhayes@blm.gov]
Sent: Friday, March 23, 2018 2:22 PM
To: Wendy Loya <wendy_loya@fws.gov>
Subject: Fwd: Consultation with Tribes, Corporations on 1002

Please let me know when you have a chance to discuss...

Thanks!

Nicole

Nicole Hayes

Project Coordinator

Bureau of Land Management

222 W. 7th Avenue #13

Anchorage, Alaska 99513

Desk: (907) 271-4354

---------- Forwarded message ----------
From: **Murphy, Ted** <t75murph@blm.gov>
Date: Thu, Mar 22, 2018 at 4:51 PM
Subject: Fwd: Consultation with Tribes, Corporations on 1002
To: "Miriam (Nicole) Hayes" <mnhayes@blm.gov>

Does this differ from what we have already?

---------- Forwarded message ----------
From: **Siekaniec, Greg** <greg_siekaniec@fws.gov>
Date: Thu, Mar 22, 2018 at 10:07 AM
Subject: Fwd: Consultation with Tribes, Corporations on 1002
To: Ted Murphy <t75murph@blm.gov>

My apology for not sending this earlier.

greg

---------- Forwarded message ----------
From: **Leonetti, Crystal** <crystal_leonetti@fws.gov>
Date: Tue, Mar 20, 2018 at 10:03 AM
Subject: Consultation with Tribes, Corporations on 1002
To: Gregory Siekaniec <greg_siekaniec@fws.gov>
Cc: Steve Berendzen <steve_berendzen@fws.gov>

Greg,

The DOI Policy on Consultation with Indian Tribes says that we shall consult on any "Departmental Action with Tribal Implications", which is defined as *any Departmental regulation, rulemaking, policy, guidance, legislative proposal, grant funding formula changes, or operational activity that may have a substantial direct effect on an Indian Tribe on matters including, but not limited to: 1.) Tribal cultural practices, land, resources, or access to traditional areas of cultural or religious importance on federally managed lands.* It also says that "the appropriate Departmental officials are those individuals who are knowledgeable about the matters at hand, are authorized to speak for the Department, and exercise delegated authority in the disposition and implementation of an agency action."

To remain consistent with policy, DOI attendees should be DOI officials at the decision making level (D.C. level), along with subject matter experts (land, resources, wildlife) and a liaison (suggest Hollis Twitchell) should consult with the Native Village of Kaktovik, Venetie Traditional Council, Village of Arctic Village, Venetie Tribal Government, Inupiat Community of the Arctic Slope and possibly Native Village of Fort Yukon/Gwichyaa Zhee and Native Village of Barrow.

The village and regional corporations in the area should also be consulted.

The scheduling of the meetings should be in close coordination with what works for the tribes. Hollis has a respectful working relationship with the tribes and is excellent at making sure the entire council is available to meet and has materials on the subject of the meeting in advance.

Crystal (Ciisquq) Leonetti, Yupik

Alaska Native Affairs Specialist

Alaska Region - R7 External Affairs **tEAm**

U.S. Fish & Wildlife Service

1011 E. Tudor Road

Anchorage, AK 99503

Direct: 907-786-3868

Mobile: 907-230-8419

“Consultation is a process that aims to create effective collaboration with Indian tribes and to inform Federal decision-makers. Consultation is built upon government-to-government exchange of information and promotes enhanced communication that emphasizes trust, respect, and shared responsibility. Communication will be open and transparent without compromising the rights of Indian tribes or the government-to-government consultation process.” –S.O. 3317 (Department of the Interior Policy on Consultation with Indian Tribes)

--

Ted A Murphy

Alaska-Associate State Director

907-271-5076

From: Arthur, Stephen
To: Hollis Twitchell
Subject: subsistence monitoring needs
Date: Tuesday, March 27, 2018 11:16:24 AM
Attachments: subsistence.xlsx

Hi Hollis,

I've been working on consolidating and prioritizing the research needs identified in the resource assessments and I was wondering about the recommendation for assessing subsistence resource use. Does this include the caribou harvest monitoring program you have been working on with the villages? And, can you take a quick look at this table and see if I have adequately summarized the needs you were thinking of? And finally, are you still pursuing a tribal wildlife grant for the caribou harvest monitoring program?

Thanks,
Steve

Stephen M. Arthur, Ph.D.
Supervisory Wildlife Biologist
Arctic National Wildlife Refuge
101 12th Ave., Room 236
Fairbanks, AK 99701
(907)455-1830

Purpose	Need	Recommended Action	Projected Annual Cost
Establish a Subsistence Harvest Monitoring Program for caribou	To ensure long-term conservation of fish and wildlife subsistence species and subsistence uses for qualified subsistence users (ANILCA)	Community-based monitoring of caribou harvests, in collaboration with local tribal governments, is needed to assess long-term trends in caribou use and availability to subsitence harvesters. This program is needed to complement similar monitoring work ongoing in Canada.	Tribal Wildlife grant?
Update subsistence use assessment for Kaktovik. Ask Wendy/BLM about 810 writing and funding?	To ensure long-term conservation of fish and wildlife subsistence species and subsistence uses for qualified subsistence users (ANILCA)	The majority of the ethnographic and subsistence data for Kaktovik and the 1002 area was collected in the 1980s and may not accurately portray current patterns in subsistence use, demographics, harvest amounts, hunting seasons, locations, or community needs.	$50,000 - $100,000

From: Leonetti, Crystal
To: Berendzen, Steve
Cc: Wendy Loya; Hollis Twitchell; Nicole Hayes; Joanna Fox
Subject: Re: Request for updated list of communities for consultation
Date: Friday, March 30, 2018 3:49:55 PM

Hi Steve,
The answer is yes. However, CATG and TCC are not federally recognized tribes on the BIA list of Tribes, while ICAS is. Therefore, consultation with CATG and TCC are not required and would not be considered government to government. It's doesn't preclude us from consulting them, so I agree it would be good to reach out to them to ask if they are interested in meeting on the topic.

Thanks,
Crystal

On Fri, Mar 30, 2018 at 1:38 PM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:

> Crystal,
>
> I'm suggesting that we offer to consult with the same tribal entities that we offered to consult with through the CCP process:
>
> - Gwichyaa Zhee in Ft Yukon
> - NVK, Kaktovik
> - Stevens Village
> - Venetie Tribal Gov't
> - Anaktuvuk Pass
> - Beaver
> - Birch Creek
> - Chalkytsik
> - Circle
>
> In addition, I think it would be good to include both Venetie and Arctic Village Councils, as well as Barrow and ICAS as you suggested. However, if you offer to consult with a North Slope consortium of tribes (ICAS), should the same be done for the Gwich'in with an invitation to CATG or possibly TCC?
>
> Steve Berendzen
> Refuge Manager, Arctic National Wildlife Refuge
> 907-456-0253
>
> On Thu, Mar 29, 2018 at 10:32 AM, Wendy Loya <Wendy_loya@fws.gov> wrote:
>
>> Hi Hollis and Steve,
>>
>> Would you please send Crystal a list of communities that you recommend receive invitations for Government to Government consultation regarding the Coastal Plain EIS? Her original recommendation accidentally omitted Chalkyitsik, and I believe you mentioned that tribal organizations for Venetie and Arctic Village needed clarification and

that there were other communities you might recommend. She can then prepare an updated request to share with Greg for forwarding to BLM.

Thank you,

Wendy

Dr. Wendy M. Loya, Coordinator

Office of Science Applications -Arctic Program

US Fish and Wildlife Service

Anchorage, Alaska

907.786.3532 (office)

907.277.2942 (mobile)

---------- Forwarded message ----------
From: **Leonetti, Crystal** <crystal_leonetti@fws.gov>
Date: Tue, Mar 20, 2018 at 10:03 AM
Subject: Consultation with Tribes, Corporations on 1002
To: Gregory Siekaniec <greg_siekaniec@fws.gov>
Cc: Steve Berendzen <steve_berendzen@fws.gov>

Greg,

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To remain consistent with policy, DOI attendees should be DOI officials at the decision making level (D.C. level), along with subject matter experts (land, resources, wildlife) and a liaison (suggest Hollis Twitchell) should consult with the Native Village of Kaktovik, Venetie Traditional Council, Village of Arctic Village, Venetie Tribal Government,

Inupiat Community of the Arctic Slope and possibly Native Village of Fort Yukon/Gwichyaa Zhee and Native Village of Barrow.

The village and regional corporations in the area should also be consulted.

The scheduling of the meetings should be in close coordination with what works for the tribes. Hollis has a respectful working relationship with the tribes and is excellent at making sure the entire council is available to meet and has materials on the subject of the meeting in advance.

Crystal (Ciisquq) Leonetti, Yupik

Alaska Native Affairs Specialist

Alaska Region - R7 External Affairs **tEAm**

U.S. Fish & Wildlife Service

1011 E. Tudor Road

Anchorage, AK 99503

--

Crystal (Ciisquq) Leonetti, Yupik
Alaska Native Affairs Specialist
Alaska Region - R7 External Affairs **tEAm**
U.S. Fish & Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503

Direct: 907-786-3868
Mobile: 907-230-8419

"Consultation is a process that aims to create effective collaboration with Indian tribes and to inform Federal decision-makers. Consultation is built upon government-to-government exchange of information and promotes enhanced communication that emphasizes trust, respect, and shared responsibility. Communication will be open and transparent without compromising the rights of Indian tribes or the government-to-government consultation process." –S.O. 3317 (Department of the Interior Policy on Consultation with Indian Tribes)

From:	Berendzen, Steve
To:	Leonetti, Crystal
Cc:	Wendy Loya; Hollis Twitchell; Nicole Hayes; Joanna Fox
Subject:	Re: Tribal/ANCSA consultation on 1002
Date:	Friday, March 30, 2018 3:54:34 PM

Crystal, I guess I should have worked through my old emails backwards. This list looks better, but when Hollis and I discussed this he made a couple points that suggest some changes to this list; Nuiqsut doesn't have the connection to Kaktovik and the Coastal Plain that Barrow has, so he didn't think it was necessary to include. Circle was on the CCP list and could be included for consistency purposes, but could probably be excluded since they are the furthest removed from the Porcupine Caribou herd's range and influence of trade for their products.

Steve Berendzen
Refuge Manager, Arctic National Wildlife Refuge
907-456-0253

On Thu, Mar 29, 2018 at 11:25 AM, Leonetti, Crystal <crystal_leonetti@fws.gov> wrote:

> Here is the email that was an updated/corrected, and more comprehensive version of the one you forwarded. Please use this email.
> Thank you,
> Crystal
>
> ---------- Forwarded message ----------
> From: **Siekaniec, Greg** <greg_siekaniec@fws.gov>
> Date: Tue, Mar 20, 2018 at 3:28 PM
> Subject: Fwd: Tribal/ANCSA consultation on 1002
> To: Crystal Leonetti <crystal_leonetti@fws.gov>
>
> I meant to add you to the note but tend to send and then realize I missed an addressee.
>
> greg
> ---------- Forwarded message ----------
> From: **Siekaniec, Greg** <greg_siekaniec@fws.gov>
> Date: Tue, Mar 20, 2018 at 3:27 PM
> Subject: Fwd: Tribal/ANCSA consultation on 1002
> To: "Wackowski, Stephen" <stephen_wackowski@ios.doi.gov>
>
> Steve,
>
> Please see the note from Crystal. Her guidance is spot on from my experience here in AK. I will again add the idea that consultation and public scoping should not be "blended" into the same visit as it will likely be construed as we are treating the tribe or corporation as just another member of the "public".
>
> greg

---------- Forwarded message ----------
From: **Leonetti, Crystal** <crystal_leonetti@fws.gov>
Date: Tue, Mar 20, 2018 at 3:17 PM
Subject: Tribal/ANCSA consultation on 1002
To: Gregory Siekaniec <greg_siekaniec@fws.gov>

Hi Greg,

Thanks for asking about consulting with tribes and ANCSA corporations on the 1002 lease sale draft EIS. I am reminded as I read through the DOI policy on consultation with Indian tribes (*excerpt below) that it is not the Federal government's choice to decide who to consult. We should reach out to any potentially affected tribal governments and ask them whether they would like to consult. As an example, Arctic Refuge staff reached out to 11 of the tribes listed in the CCP consultation list, but only 4 tribes decided to consult. The rest of them decided to keep informed through regular communication, but not to engage in formal consultation.

I recommend that we reach out to the following tribes via phone to determine their level of interest, then send a letter based on their response about their desired level of engagement:
Native Village of Kaktovik
Venetie Traditional Council
Village of Arctic Village
Venetie Tribal Government
Inupiat Community of the Arctic Slope
Gwichyaa Zhee Gwich'in Tribal Government/Native Village of Fort Yukon
Native Village of Barrow
Native Village of Stevens
Naqsragmiut Tribal Government/Village of Anaktuvuk Pass
Beaver Traditional Council
Chalkyitsik Village Council
Dundu Gwich'in/Birch Creek Village Council
Native Village of Nuiqsut

I also recommend that we reach out to the following ANCSA corporations in the same manner:
Arctic Slope Regional Corporation
Kaktovik Inupiat Corporation

To remain consistent with policy, DOI attendees should be DOI officials at the decision making level (D.C. level), along with subject matter experts (land, resources, wildlife) and a liaison (suggest Hollis Twitchell) should be present and engaged at the meetings. The smaller the Federal crowd, the better.

Scheduling of meetings should be in close coordination with tribes. Hollis has a respectful working relationship with the tribes and is excellent at making sure the entire council is available to meet and that they have materials on the subject of the meeting in advance.

I agree with the idea that the 2 DOI agencies consult together. This is consistent with requests from Tribes that we reduce our burden on them by coordinating our consultation meetings.

*The DOI Policy on Consultation with Indian Tribes says that we shall consult on any "Departmental Action with Tribal Implications", which is defined as *any Departmental regulation, rulemaking, policy, guidance, legislative*

proposal, grant funding formula changes, or operational activity that may have a substantial direct effect on an Indian Tribe on matters including, but not limited to: 1.) Tribal cultural practices, land, resources, or access to traditional areas of cultural or religious importance on federally managed lands. It also says that "*the appropriate Departmental officials are those individuals who are knowledgeable about the matters at hand, are authorized to speak for the Department, and exercise delegated authority in the disposition and implementation of an agency action.*"

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--

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From: Berendzen, Steve
To: Hollis Twitchell
Subject: Fwd: FWS recommended invitations for Tribal/ANCSA consultation on 1002
Date: Tuesday, April 3, 2018 7:59:46 PM

Hollis,

We (mostly I, since you're likely flying moose surveys :) need to get names, addresses, and phone #'s if available to send to Nicole Hayes for the list of contacts below to initiate consultation if they desire.

I've got that information for all but ASRC, Anaktuvuk Pass, and Nuiqsut. Any quick listings that you can suggest, or should I look up offices on the internet and call for specifics?

Steve Berendzen
Refuge Manager, Arctic National Wildlife Refuge
907-456-0253

---------- Forwarded message ----------
From: **Wendy Loya** <Wendy_loya@fws.gov>
Date: Tue, Apr 3, 2018 at 9:14 AM
Subject: FWS recommended invitations for Tribal/ANCSA consultation on 1002
To: Greg Siekaniec <greg_siekaniec@fws.gov>, Karen Clark <karen_clark@fws.gov>
Cc: Crystal Leonetti <crystal_leonetti@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>

Hi Greg and Karen,

There has been some confusion about the recommended list of communities that FWS believes should be invited to consult on the Coastal Plain EIS. Below is what I understand to be the complete list of communities that the FWS via Crystal Leonetti recommends be invited to consultation after further discussions she has had with BLM's Alaska Native Affairs Specialist and the Arctic Refuge staff. This list would replace the shorter list that we shared with BLM on March 22 in an email from Greg to Ted Murphy.

If you agree with this revised list, can you please forward to Ted, and cc'ing me and Nicole Hayes mnhayes@blm.gov?

Thank you,

Wendy

I recommend that we reach out to the following tribes via phone to determine their level of interest, then send a letter based on their response about their desired level of engagement:

Native Village of Kaktovik

Venetie Traditional Council

Village of Arctic Village

Venetie Tribal Government

Inupiat Community of the Arctic Slope

Gwichyaa Zhee Gwich'in Tribal Government/Native Village of Fort Yukon

Native Village of Barrow

Native Village of Stevens

Naqsragmiut Tribal Government/Village of Anaktuvuk Pass

Beaver Traditional Council

Chalkyitsik Village Council

Dundu Gwich'in/Birch Creek Village Council

Native Village of Nuiqsut

I also recommend that we reach out to the following ANCSA corporations in the same manner:

Arctic Slope Regional Corporation

Kaktovik Inupiat Corporation

To remain consistent with policy, DOI attendees should be DOI officials at the decision making level (D.C. level), along with subject matter experts (land, resources, wildlife) and a liaison (suggest Hollis Twitchell) should be present and engaged at the meetings. The smaller the Federal crowd, the better.

Scheduling of meetings should be in close coordination with tribes. Hollis has a respectful working relationship with the tribes and is excellent at making sure the entire council is available to meet and that they have materials on the subject of the meeting in advance.

I agree with the idea that the 2 DOI agencies consult together. This is consistent with requests from Tribes that we reduce our burden on them by coordinating our consultation meetings.

*The DOI Policy on Consultation with Indian Tribes says that we shall consult on any "Departmental Action with Tribal Implications", which is defined as *any Departmental regulation, rulemaking, policy, guidance, legislative proposal, grant funding formula changes, or operational activity that may have a substantial direct effect on an Indian Tribe on matters including, but not limited to: 1.) Tribal cultural practices, land, resources, or access to traditional areas of cultural or religious importance on federally managed lands.* It also says that "*the appropriate Departmental officials are those individuals who are knowledgeable about the matters at hand, are authorized to speak for the Department, and exercise delegated authority in the disposition and implementation of an agency action.*"

Crystal (Ciisquq) Leonetti, Yupik

Alaska Native Affairs Specialist

Alaska Region - R7 External Affairs **tEAm**

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From:	Lanctot, Richard
To:	Stephen Brown; Christopher Latty; Roy Churchwell; Jim Lyons; Sarah Saalfeld
Subject:	Fwd: NFWF grant funded - 1002 helicopter surveys in 2019
Date:	Wednesday, April 4, 2018 6:22:41 PM
Attachments:	AK Fish and Wildlife Program_FY18.xls

Hi All, Just got word that the helicopter survey work for the 1002 was funded.

Cheers, Rick

****

Richard Lanctot, PhD
Region 7 Shorebird Coordinator
U.S. Fish and Wildlife Service
1011 East Tudor Road, MS 201
Anchorage, Alaska 99503
Ph: 907-786-3609
Fax: 907-786-3641
Cell: 907-440-9733
E-mail: richard_lanctot@fws.gov

****
"Hockey is Life - Keep your stick on the ice!" Unknown author

---------- Forwarded message ----------
From: **Wigglesworth, David** <david_wigglesworth@fws.gov>
Date: Wed, Apr 4, 2018 at 4:01 PM
Subject: NFWF
To: Eric Taylor <eric_taylor@fws.gov>
Cc: Richard Lanctot <richard_lanctot@fws.gov>

funded projects.

--
David Wigglesworth
Deputy ARD/Fish & Aquatic Conservation
US FWS Region 7
1011 East Tudor Rd
Anchorage, AK 99503
direct: 907-786-3925
cell: 907-301-3943
email: david_wigglesworth@fws.gov

Organization Legal Name	Project Title	Project Description	Start Date	End Date	Request Amount	Recommended Award
Alaska Department of Fish and Game	Anadromous Cataloging and Fish Inventory in Select Drainages of the Kobuk and Koyukuk Rivers	In summer of 2018, department staff will conduct a rapid, systematic inventory of anadromous and resident fish distribution and associated aquatic and riparian habitat in select drainages of the Kobuk and Koyukuk rivers. Using establish protocols, target streams will be selected to fill gaps in the coverage of the State of Alaska's Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes (AWC) in freshwater habitats expected to support anadromous fish populations likely to be impacted by human activities.	7/1/2018	6/30/2019	$48,170.00	**$48,170.00**
Southeast Alaska Watershed Coalition	Klawock Lake Sockeye and Pacific Salmon Management and Habitat Restoration, Prince of Wales Island	Sockeye salmon from Klawock Lake have been important to people for thousands of years. Despite past restoration efforts, it is evident that abundance over the last two decades is significantly less than historical values. In 2017, TNC and the Southeast Alaska Fish Habitat Partnership, with support from numerous agency, community, and tribal partners, convened a stakeholder meeting to evaluate the causes and effectiveness of actions to address decline. The meeting also highlighted the island-wide need for increased community capacity to manage and restore habitat. This has set the stage for the development of a Klawock Sockeye Salmon Community Action Plan – a plan developed with multiple stakeholders and the community to collectively address sockeye salmon declines. The Southeast Alaska Watershed Coalition (SAWC) and The Nature Conservancy will take direct actions to improve management and habitat of Klawock Sockeye and Pacific Salmon on Prince of Wales Island.	6/1/2018	5/29/2020	$61,010.27	**$61,010.27**

Takshanuk Watershed Council	Chilkat and Chilkoot Water Quality Monitoring: Chemistry and Temperature	Starting in 2015, the Takshanuk Watershed Council (TWC) began working with the Chilkat Indian Village of Klukwan (CIV), a federally recognized Alaska Native government, on developing and implementing programs for the long-term monitoring of surface water chemistry and temperature in the Chilkat Valley. In partnership with the US EPA and the Alaska DEC, TWC and CIV developed a Quality Assurance Project Plan (QAPP) for the gathering of baseline water chemistry data at three sites on the Klehini River, a major tributary of the Chilkat. The project is partly in response to ongoing mineral exploration in the Klehini River watershed, as well as the nomination of the Chilkat River for Outstanding National Resource Water status under the federal Clean Water Act. With funding from NFWF, TWC will expand the stream temperature and chemistry monitoring programs.	10/1/2018	10/1/2019	$16,723.08	**$16,723.08**
U.S. Fish and Wildlife Service - Region 7	Using Unmanned Aerial Vehicles (UAV, "Drone") with Thermal Imaging Cameras to Detect and Monitor Sea Bird Nests on the North Slope of Alaska.	Aid in recovery efforts for Steller's and spectacled eiders in Alaska by using UAS (Unmanned Aircraft Systems, "Drone's") and thermal imaging software to increase nest discovery and monitoring methods for sea birds on the North Slope of Alaska. This project will include an outreach program that promotes community involvement in conservation, increased knowledge of tundra nesting sea bird ecology, and provide summer employment opportunities for local youth.	4/2/2018	8/30/2021	$60,000.00	**$60,000.00**
Wildlife Conservation Society	Protecting Coastal Lagoons in the Southern Chukchi Sea: Project Chariot Revisited	Repeat historical surveys of four coastal lagoons at Cape Thompson with standardized protocols developed by the National Park Service as part of their long-term monitoring Vital Sign program in the Cape Krusenstern and Bering Land Bridge park units; specifically, we will assess productivity, whitefish and forage fish abundance, and importance as waterbird nesting and staging habitats. Project will provide essential data for Alaska Department of Environmental Conservation’s Geographic Response Planning and the National Oceanic and Atmospheric Administration’s Arctic Environmental Response Management Application that prioritizes coastal lagoons across the entire southern Chukchi coast for deployment of limited human and material resources, particularly response equipment, in the event of an oil spill.	6/1/2018	5/31/2020	$119,861.99	**$119,861.99**

Manomet, Inc.	Determining avian population trends in the 1002 Area of the Arctic National Wildlife Refuge	We propose to conduct a shorebird survey of the entire 1002 Area in the Arctic National Wildlife Refuge following protocols developed by the Program for Regional and International Shorebird Monitoring (PRISM). This survey will provide the first assessment of shorebird population change for the 1002 Area since it was initially surveyed in 2002-4, and will also provide critical information about the distribution and habitat use of shorebirds breeding in the area. These data will support both the range-wide population trend estimation goals of PRISM, and also provide important baseline data on shorebird status and trends before any proposed oil and gas exploration occurs, so that mitigation measures can adequately replace any lost habitat functions. The new population estimates for the entire 1002 area will help target conservation actions both locally and range-wide if declines are observed for one or more shorebird species.	3/1/2018	3/1/2020	$79,716.21	**$79,716.21**
Yukon Delta Fisheries Development Association	Juvenile Chinook Salmon Outmigration at the Yukon River Mouth	This research will provide information to fill gaps in knowledge of juvenile Yukon Chinook salmon necessary to understanding survival and recruitment dynamics. The research will: 1) Quantify outmigration timing from ice out through the end of August. These data are important for ascertaining outmigration phenology in relation to environmental variation, and can be used to identify critical recruitment periods affecting salmon stocks. 2) Quantify juvenile Chinook salmon size, growth, diet, energetic condition, and smolting stage in relation to environmental variables. These data will provide important information on juvenile Chinook salmon growth and survival heading into their first marine summer. 3) Provide data on genetic composition of outmigrating Chinook salmon. This study is the only source of data on genetic composition of Chinook salmon as they leave the Yukon River and as such provides vital information for stock composition analysis and management.	4/1/2018	4/30/2019	$121,105.00	**$82,105.00**

US Fish and Wildlife Service, Fairbanks Conservation Office	East Fork Andreafsky River Chinook and summer chum salmon escapement project	The East Fork Andreafsky River weir is a floating panel, resistance board weir with an underwater video monitoring system, designed for accurate counting of Chinook and summer chum salmon escapement in this important tributary of the Yukon River. Information provided by the project will include daily migration counts, full season run timing, total seasonal escapement estimates, and annual age, sex, and length composition of Chinook and summer chum salmon spawning populations. Other useful information to be collected will include daily migration counts and observations of other salmon and non-salmon species, video images of all fish passing the weir, and daily water level and temperature and weather conditions. Information from the project is used daily by inseason subsistence fishery managers, and is analyzed post-season to contribute to Yukon River drainagewide salmon run reconstructions and forecasts for the next season.	4/1/2018	6/30/2019	$110,875.16	**$37,200.00**

From: Trawicki, John
To: Wendy Loya; Charles Hamilton; Greta Burkart; Edward Decleva; Peter Butteri; Paul Leonard; Janet Jorgenson; Randy Brown; Christopher Latty; Richard Lanctot; Stephen Lewis; Michael Swaim; Julian Fischer; Ted Swem; Roy Churchwell; Stephen Arthur; Ryan Wilson; Hollis Twitchell; Susanne Miller; Jennifer Reed; Angela Matz
Subject: Fwd: Cumulative Effects Workshop- Anchorage and Fairbanks- next week
Date: Monday, April 9, 2018 1:21:46 PM

With your potential participation in the EIS for the coastal plain, Arctic NWR you may want to consider taking this class. There are several on-line training classes to refresh your knowledge and understanding of NEPA and the process. They are available through DOI learn.

Search for : BLM-TC-1620

You can also find several valuable resources through these classes.

john t
---------- Forwarded message ----------
From: **Trawicki, John** <john_trawicki@fws.gov>
Date: Wed, Apr 4, 2018 at 8:07 AM
Subject: Cumulative Effects Workshop- Anchorage and Fairbanks- next week
To: Stephanie Brady <stephanie_brady@fws.gov>, Joanna Fox <joanna_fox@fws.gov>, Doug Damberg <doug_damberg@fws.gov>, Socheata Lor <Socheata_Lor@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, Stephen Arthur <stephen_arthur@fws.gov>, Wendy Loya <wendy_loya@fws.gov>, "Fischbach, Tracy" <tracy_fischbach@fws.gov>, Drew Crane <drew_crane@fws.gov>, John W Martin <John_W_Martin@fws.gov>

FYI- Cumulative Effects Workshop- Anchorage and Fairbanks- seats still available-

Register through DOI Learn

Anchorage: 4/16-17

BLM-2018-0416-Anchorage, AK 1620-14c

Fairbanks: 4/19-20

BLM-2018-0419-Fairbanks, AK 1620-14c

Nicole mentioned this class yesterday. Would be valuable to those working on NEPA projects.

Course Name:

Cumulative Effects Analysis Workshop

Status:

Active

Description:

Pre-requisite: Participants must take the online course NEPA: Cumulative Effects Analysis Basics, Module 1 (1620-14A), in DOI Learn, and pass the post-test with 75% or higher before attending this class. This online course introduces you to the terminology and 7-step cumulative effects analysis process from the BLM NEPA Handbook (2008).

There's also an optional, but recommended, Cumulative Effects Analysis Applications, Module 2 (1620-14B), which illustrates each step of the analysis process using four typical BLM actions. You can review just one or all four examples.

Finally, since this is an intermediate workshop, if you are not thoroughly familiar with the BLM's NEPA process, we also recommend that you take the online NEPA Analysis Process for BLM (1620-02), which is based on Chapter 6 of the BLM NEPA Handbook.

Course Description: The overall goal of this 3-part cumulative effects analysis training is to show you how to improve your NEPA documents by writing more robust cumulative effects analyses, starting with writing good issue and purpose and need statements.

This 2-day workshop is the 3rd part of the series. We bring the workshop to your BLM office. The instructors will help your interdisciplinary team complete a cumulative effects analysis for a project you're currently working on.

Objectives: Upon completion of this workshop, the participant should be able to complete a cumulative effects analysis consistent with CEQ and BLM guidance, that will withstand legal challenge, and that will help inform a sound decision.

Target Audience: This course is for a BLM interdisciplinary team who is working on a specific project for which they want help doing the cumulative effects analysis. The team lead can invite other non-BLM employees, as necessary.

Course Length: 2 days (generally starting at about 9:30am on Day 1 and ending by 4:00pm on Day 2

Cost: There is no tuition for this course.

Registration: Participants must register through DOI Learn (http://www.doi.gov/doilearn/index.cfm)

Special Requirements: This course consists of two 7-hour days of classroom training, mostly sitting at a table. The facility is ADA (Americans with Disabilities Act) accessible. Lunch is on your own. You are responsible for your own transportation to/from the training. Requests for interpreters or other special requirements must be received at the NTC no later than 45 days prior to the start of the class. Form can be accessed at: http://www.blm.gov/ntc/st/en/reasonable_accommodation.html

Keyword: NEPA Analysis, Cumulative Effects, 620-14C

Delivery Type:	Instructor Led
Course Code:	BLM-TC-1620-14C
Vendor:	BLM National Training Center
Duration:	16 hours
Contact:	Tessa Teems, tteems@blm.gov
Responsible Bureau:	Bureau of Land Management

--
John Trawicki
Water Resources Branch Chief
National Wildlife Refuge System, Alaska
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503
Work: (907) 786-3474
Mobile: (907) 360-1656

"The single biggest problem with communication is the illusion that it has taken place"
George Bernard Shaw

--
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Water Resources Branch Chief
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Anchorage, AK 99503
Work: (907) 786-3474
Mobile: (907) 360-1656

"The single biggest problem with communication is the illusion that it has taken place"
George Bernard Shaw

From:	Fox, Joanna
To:	Stephen Arthur; Hollis Twitchell; Jennifer Reed; Roger Kaye
Subject:	Fwd: Anticipated questions to address in 1002 Comms plan?
Date:	Tuesday, April 10, 2018 11:56:52 AM

Folks - what are the questions you envision we may be asked at public meetings associated with oil and gas development in the coastal plain that will be difficult or uncomfortable to answer? If you have some ideas, please add them to the "anticipated questions" document Wendy has created. This will help External Affairs develop a communications plan with good talking points for our use after the NOI is released (which may well be this week).

Please take a few minutes to think about this asap. If you can't access the link or don't have edit privileges, please let me know.

Thank you!
Joanna

____
Joanna L. Fox
Deputy Refuge Manager
Arctic National Wildlife Refuge
101 12th Avenue, Room 236
Fairbanks, AK 99701
(907) 456-0549

Follow us on Facebook!
www.facebook.com/arcticnationalwildliferefuge

“Do what you can, with what you have, where you are.” -- Theodore Roosevelt

---------- Forwarded message ----------
From: **Wendy Loya** <Wendy_loya@fws.gov>
Date: Mon, Apr 9, 2018 at 11:07 AM
Subject: Anticipated questions to address in 1002 Comms plan?
To: John Trawicki <john_trawicki@fws.gov>, John Martin <john_w_martin@fws.gov>, Doug Damberg <doug_damberg@fws.gov>, Stephanie Brady <stephanie_brady@fws.gov>, Joanna Fox <joanna_fox@fws.gov>, Socheata Lor <socheata_lor@fws.gov>, Steve Berendzen <steve_berendzen@fws.gov>, Tracy Fischbach <tracy_fischbach@fws.gov>, Mitch Ellis <mitch_ellis@fws.gov>, Drew Crane <drew_crane@fws.gov>, Eric Taylor <eric_taylor@fws.gov>, Mary Colligan <mary_colligan@fws.gov>, Carl Johnson <carl_johnson@fws.gov>, Sarena Selbo <sarena_selbo@fws.gov>
Cc: Sara Boario <sara_boario@fws.gov>, Andrea Medeiros <andrea_medeiros@fws.gov>

Hi 1002 team and colleagues,

I have created a Google doc to collate questions you have been asked or anticipate being asked about the 1002 EIS and Oil and Gas Program with regards to FWS, the natural resources and Arctic Refuge overall. This info will help guide our FWS External Affairs staff in working with HQ on a communications plan. I would say to focus on the immediate needs of

outreach to communities/public and responding to inquiries during public scoping after the NOI is released. BLM and DOI will take the lead on communications related to the EIS, so that is one talking point we can flesh out so it is clear to everyone regardless of their involvement in the process.

https://docs.google.com/document/d/1jj2MeLMw1aG3MbGrGY4NwyjyhoFBgDJAwp4vL4UQVV4/edit?usp=sharing

Joanna and I will circle back with Andrea and Sara mid-week, so please participate if you wish to as soon as possible.

Dr. Wendy M. Loya, Coordinator
Office of Science Applications -Arctic Program
US Fish and Wildlife Service
Anchorage, Alaska
907.786.3532 (office)
907.277.2942 (mobile)

FAQs for FWS-Alaska Region regarding the publication of the Notice of Intent to Prepare an Environmental Impact Statement for the Coastal Plain Oil and Gas Leasing Program, Alaska

1) **What are the roles of the FWS and BLM in opening the 1002 area to oil and gas?**

Title II, Section 20001 of the Tax Act directs the Secretary of the Interior, acting through the Bureau of Land Management (BLM), to establish and administer a competitive oil and gas leasing program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain. The Secretary of the Interior is directed to manage the oil and gas program on the Coastal Plain in a manner similar to the administration of lease sales under the Naval Petroleum Reserves Production Act of 1976 (including regulations).

The FWS is a cooperating agency in the preparation of the Environmental Impact Statement. FWS will focus their review and support on those issues and resources on which they have special expertise or jurisdiction by law, on those issues which may affect natural resources for which they are responsible, or on the issues as they pertain to the individual agency's decision making process.

2) **What input processes will the public have to speak about the development phase, if this EIS is just about exploration and leasing?**

3) **When do you anticipate on-the-ground exploration (and its staging) to begin?**

4) **What months in each year will exploration activities occur?**
5) **How many years do you expect exploration to last?**
6) **Is 3-D seismic expected to occur across the whole of the 1002 Area? If not, where are the segments located that are expected to be explored?**
7) **What input processes will the public have to speak about the development phase, if this EIS is just about exploration and leasing?**
8) **What does "National Wildlife Refuge" mean if it doesn't mean protecting animals and their habitats?**
9) **Do you have enough information to evaluate the impacts of exploration and leasing on the refuge, especially for caribou?**
10) **How will X be impacted by exploration, leading and development?**
    a) How will subsistence resources, and access to those resources, be impacted by exploration, leasing and development?
    b) How will the daily lives of residents of Kaktovik be changed because of exploration and leasing activities that affect the community of Kaktovik? Will there be increased need for law enforcement of drug and alcohol impacts? Will there be increased needs for social services? How will these needs be addressed? How will these needs change with development?

c) How will recreation resources be impacted by exploration, leasing and development?
d) Will visitor access to recreation resources be impacted by exploration, leasing and development?
e) Will visitor access to recreation resources be impacted by exploration, leasing and development?
f) I have been planning a trip to this area for years. How will my experience be different because exploration is being staged or is happening?
g) Will hunting, fishing, birding, river floating, hiking experience qualities be reduced by increased air traffic or other impacts because of exploration, leasing and development?
h) How will polar bear viewing on the waters surrounding Kaktovik be impacted by oil and gas exploration and development activities?
i) How will polar bear viewing on lands within Kaktovik managed by non-Refuge land managers be impacted by exploration, leasing and development?
j) What will the landscape of the 1002 Area look like after exploration is completed?
k) How long would it take for the visual impacts to the landscape to recover?
l) What exactly will be the impacts to the ground from 3-D seismic exploration?
m) Ice roads require an abundant source of water, but snow trails require consistent snow cover, which does not exist on the wind-scoured Coastal Plain. How will snow trails prevent damage to the landscape?
n) I own a small, family-run business serving clients who visit Arctic Refuge. Most of my business is in the Coastal Plain. Will the viability of my business be affected? Who will compensate me if my recreational-focused business is reduced?

11) **Who will oversee the monitoring program for on-the-ground exploration? BLM? FWS? If BLM, what say will FWS have**?
12) **How will the aquatic habitats important to fish, birds, invertebrates be protected?**
13) **Will I be able to use and access airstrips and roads constructed for oil and gas development for hunting and other recreational activities?**
    a) Who sets the rules for minimum snow cover and hardness to allow exploration and accompanying camp trains?
    b) What are the minimum snow levels and snow hardness under which 3D exploration and camp moves will be allowed?
    c) Who will monitor on-site, day-to-day compliance with snow level requirements?
    d) What is the process for dispute of monitoring compliance?
    e) What funding is available to pay for compliance monitoring?
    f) What level of authority will monitors have to restrict exploration and accompanying activities when snow levels are too low to minimize impacts to the landscape?
    g) Where will monitors be living and how will they be transported across the Coastal Plain?
    h) Can villagers get these monitoring jobs?

i) How will gray water and sewage management of workers on the Coastal Plain be mitigated during exploration, leasing and development?
j) Is 3-D seismic the only way exploration be undertaken, or will there be additional impacts?
k) How many people will be involved in the exploration work and where will they be living (in train camps adjacent to the snow trails?)? What will be the additional impacts of these to the landscape?
l) Will the topography change to a crest/trough surface as the vegetation in seismic trails changes to a wetter sedge as we saw with 2-D seismic exploration?
m) Will winter subsistence activities be impacted by topography changes, making it harder for snow machines to traverse the newly uneven landscape?
n) How will these topography changes and other ground impacts affect access?
o) How will these topography changes and other ground impacts affect drainage across the Coastal Plain, and what are the anticipated consequences to the landscape, water regime, bird life, fish life, and wildlife?
p) What are the plans for recovering after-exploration impacts from snow trails, etc.?

14) Please clarify the difference between these three things: exploration, leasing, and development. Are they different than “oil and gas development”? How? Where are the overlaps?

15) What happens if few or no companies seek leases? Is there a minimum amount of leasing that needs to occur to move forward to the development stage?

16) Energy Information Administration (EIA) Report (May 2008) requested by Senator Ted Stevens results anticipate only a mean estimate of 2.6 billion barrels from Arctic Refuge. How does this jibe with the Omnibus Bill’s forecasted economic payoffs?

17) Will there be jobs available for residents of Kaktovik and Arctic Village? How do we sign up for those jobs?

18) If the infrastructure is intended to be temporary, how will the landscape be restored?

19) Water is extremely limited in the coastal plain of the Arctic refuge, where will industry obtain the vast amounts of water necessary for exploration and/or development?

From:	Wendy Loya
To:	Stephen Arthur; Greta Burkart; Paul Leonard; Steve Berendzen; John Trawicki; Louise Smith; Doug Damberg; Jennifer Reed; Roger Kaye; Hollis Twitchell; Joanna Fox; Roy Churchwell; Drew Crane; Christopher Latty; Ted Swem; John Martin; Stephanie Brady; Tracy Fischbach; Randy Brown; Patrick Lemons; Mary Colligan
Cc:	Sarena Selbo; Mitch Ellis; Socheata Lor
Subject:	Handouts for today"s discussion on Oil and Gas Stipulations and BMPs
Date:	Wednesday, April 11, 2018 10:08:19 AM
Attachments:	NPRA IAP EIS Table 2.3 Stips and BMPs by Resource.docx 1987 Summary Mitigation Recommendations for Coastal Plain 1002 Area.docx FWS Habitat BMPs for north slope 041128.docx FWS-ES Mine Site Development and Restoration BMPs for north slope 041118.docx

Good morning,

Attached are 4 documents that we will use to guide today's discussion from 2-4 pm around Stipulations and Best Management Practices (BMPs) can be used to avoid or mitigate impacts to natural resources during exploration and development on the North Slope. **Please print a copy or bring your computer with you to the discussion**.

They include:

1. NPRA IAP EIS Table 2.3 Stips and BMPs by Resource: Now organized by natural resource subject to more easily find relevant measures (from John Martin)
2. FWS-ES Habitat BMPs for North Slope: Provided by Louise Smith in Ecological Services, these are the BMPs FWS uses in collaboration with Army Corps of Engineers for development projects on the North Slope
3. FWS-ES Mine Site Development and Restoration BMPs for north slope: as above, but for gravel mines
4. 1987 Summary Mitigation Recommendations for Coastal Plain 1002 Area: extracted from Clough et al. 1987 FEIS for Coastal Plain (from John Martin)

We are focusing on Stipulations/BMPs that most directly affect Fish and Wildlife and their habitats; there are numerous other measures to protect the environment that are important, but we won't have time to discuss them all today. Our goals are: to be familiar with these and how they are used; ensure we have the right information to support implementation at the right time; compile questions we have about them to seek additional input from experts at BLM, DNR, ADFG, Industry, etc..

Talk to you all soon,
Wendy

Dr. Wendy M. Loya, Coordinator
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REVIEW OF NPRA IAP EIS Table 2-3 (BLM 2012)

NRPA IAP EIS Table 2-3 (Vol. 1, pages 42-111, hereafter NRPA BMP/ROPs) has been reformatted from current categories:

A. Waste prevention, handling, disposal, spills, and public safety
B. Water use for permitted activities
C. Winter overland moves and seismic work
D. Oil and gas exploratory drilling
E. Facility design and construction
F. Use of aircraft for permitted activities
G. Oil and gas field abandonment
H. Subsistence consultation for permitted activities
I. Orientation programs associated with permitted activities
J. Endangered Species Act – Section 7 consultation process
K. Additional protections that apply to select biologically sensitive areas
L. Summer vehicle tundra access
M. General wildlife and habitat protection

…into the following categories, which more closely align with natural resource management:

- 1. Soils, vegetation and biotic communities
- 2. Fisheries and water quality
- 3a. Terrestrial mammals I: bears
  3b. Terrestrial mammals II: caribou
  3c. Terrestrial mammals III: other species
  3d. Wildlife general considerations (all species)
- 4. Birds (all species)
- 5. Wilderness recreational values
- 6. Restoration and rehabilitation of abandoned oilfields

1. SOILS, VEGETATION AND BIOTIC COMMUNITIES

Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.

a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and approximately May 15 in the northern coastal areas). The exact dates will be determined by the authorized officer.
b. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Low-ground-pressure vehicles shall be selected and operated in a manner that eliminates direct impacts to the tundra by shearing, scraping, or excessively compacting the tundra mat. Note: This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction.
c. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed.
d. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons.
e. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.
f. Motorized ground-vehicle use within the Colville River Special Area associated with overland moves, seismic work, and any similar use of heavy equipment shall be minimized within an area that extends 1 mile west or northwest of the bluffs of the Colville River, and 2 miles on either side of the Kogosukruk and Kikiakrorak rivers and tributaries of the Kogosukruk River from Apr 15 through Aug 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning Mar 15. Such use will remain 0.5 mile away from known raptor nesting sites, unless authorized by the authorized officer.

Minimize surface impacts from exploratory drilling.

Construction of permanent or gravel oil and gas facilities shall be prohibited for exploratory drilling. Use of a previously constructed road or pad may be permitted if it is environmentally preferred.

Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish and wildlife resources.

All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas. The authorized officer will consult with appropriate federal, State, and North Slope Borough regulatory and resources agencies prior to approving construction of roads. Subject to approval by the authorized officer, the construction, operation and maintenance of oil and gas field roads is the responsibility of the lessee unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity.

Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.

Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall be developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies and consider:

a. Locations outside the active floodplain.
b. Design and construction of gravel mine sites within active floodplains to serve as water reservoirs for future use.
c. Potential use of the site for enhancing fish and wildlife habitat.
d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope.

2. FISHERIES AND WATER QUALITY

Maintain populations of, and adequate habitat for, fish and invertebrates.

Withdrawal of unfrozen water from rivers and streams during winter is prohibited. The removal of ice aggregate from ≤4-feet deep may be authorized from rivers on a site-specific basis.

Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.

Withdrawal of unfrozen water from lakes and the removal of ice aggregate from ≤4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community. Current water use requirements are:

(a) lakes with sensitive fish (i.e., any fish except ninespine stickleback or Alaska blackfish); unfrozen water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; only ice aggregate may be removed from lakes that are ≤7-feet deep.
(b) Lakes with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish): unfrozen water available for withdrawal is limited to 30% of calculated volume deeper than 5 feet; only ice aggregate may be removed from lakes that are ≤5 feet.
(c) Lakes with no fish present, regardless of depth: water available for use is limited to 35% of total lake volume.
(d) In lakes where unfrozen water and ice aggregate are both removed, the total use shall not exceed the respective 15%, 30%, or 35% volume calculations.
(e) Additional modeling or monitoring may be required to assess water level and water quality conditions before, during, and after water use from any fish-bearing lake or lake of special concern.
(f) Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. Note: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the ADF&G.
(g) Compaction of snow cover or snow removal from fish-bearing waterbodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.

Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.

Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers, streams, and lakes shall be crossed at areas of grounded ice whenever possible.

Minimize the effects of high-intensity acoustic energy from seismic surveys on fish.

a. When conducting vibroseis-based surveys above potential fish overwintering areas (water 6 feet deep or greater, ice plus liquid depth), operators shall follow recommendations by Morris and Winters (2005): only a single set of vibroseis shots should be conducted if possible; if multiple shot locations are required, these should be conducted with minimal delay; multiple days of vibroseis activity above the same overwintering area should be avoided if possible.
b. When conducting air gun-based surveys in freshwater, operators shall follow standard marine mitigation measures that are applicable to fish (e.g., MMS 2006): operators will use the lowest sound levels feasible to accomplish their data-collection needs; ramp-up techniques will be utilized (ramp-up involves the gradual increase in emitted sound levels beginning with firing a

single air gun and gradually adding air guns until the desired operating level of the full array is obtained).

c. When conducting explosive-based surveys, operators shall follow setback distances from fish-bearing waterbodies based on requirements outlined by ADF&G (1991).

<u>Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat</u>.

Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes.

<u>Protect fish-bearing waterbodies, water quality, and aquatic habitats</u>.

Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high watermark of fish-bearing waterbodies. Essential pipeline and road crossings will be permitted on a case-by-case basis.

Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and encouraged. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling shall be accomplished through blocking rather than use of a bulldozer.

<u>Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing</u>.

Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in consultation with appropriate Federal, State, and North Slope Borough regulatory and resource agencies, shall be required to address the objectives of water quality and free passage of fish.

Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.

Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow. Note: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.

<u>Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality and protect stream banks</u>.

Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice (“bridges”) shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.

<u>Ensure the passage of fish at stream crossings</u>.

To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the BMPs *Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain* (McDonald

et al. 1994); *Fundamentals of Culvert Design for Passage of Weak-Swimming Fish* (Behlke et al. 1991); and, other peer-reviewed or generally accepted BMPs. To adhere to these BMPs, at least 3 years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream's ordinary high watermark. These data shall include, but are not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.

<u>Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values</u>.

Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. (Gravel mines may be located within the active floodplain consistent with BMP E-8). On a case-by case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings to the main channel will be permitted through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event. In the below list, if no upper limit for the setback is indicated, the setback extends to the head of the stream as identified in the National Hydrography Dataset.

a. Colville River: a 1-mile setback (2-mile setback in Alternatives B-1 and B-2) from the boundary of NPRA where the river determines the boundary along the Colville River as determined by cadastral survey to be the highest high watermark on the left (western or northern) bank and from both banks ordinary high watermark where BLM-manages both sides of the river up through T5S, R30W, U.M. Above that point to its source at the juncture of Thunder and Storm creeks the setback will be 0.5 mile. Note: The planning area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes, though the BLM would encourage minimal use of the setback area. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within National Petroleum Reserve-Alaska.
b. Ikpikpuk River: a 0.5-mile setback from of the ordinary high watermark of the Ikpikpuk River extending from the mouth south to section 19, T7N, R11W, U.M. From section 19, T7N, R11W, U.M., to section 4, T3N, R12W, U.M., a 1-mile setback is required. Beginning at section. 4, T3N, R12W, U.M., a 0.5-mile setback from the centerline (1 mile total) will be required to the confluence of the Kigalik River and Maybe Creek. In Alternative B-1 and B-2, the setback would be 2 miles from the ordinary high watermark from the mouth of the river upstream through T7 N, R11W, U.M.; above that point the setback would be the same as described above in Alternative B-1 and 1 mile in Alternative B-2.
c. Miguakiak River: a 0.5-mile setback from the bank's ordinary high watermark.
d. Kikiakrorak and Kogosukruk Rivers: A 1-mile setback from the top of the bluff (or ordinary high watermark if there is no bluff) on the Kikiakrorak River downstream from T2N., R4W, U.M. and on the Kogosukruk River (including Branch of Kogosukruk River, Henry Creek, and two unnamed tributaries off the southern bank) downstream from T2N, R3W, U.M. In Alternatives B-1 and B-2, the setback would be 2 miles from the top of the bluff (or bank if there is no bluff) for the same waterbodies. The setback from these streams in Alternatives B-1 through D in the named

townships and further upstream as applicable will be 0.5 mile from the top of the bluff or bank if there is no bluff.

e. Fish Creek: a 3-mile setback from the bank's highest high watermark of the creek downstream from the eastern edge of section 31, T11N, R1E., U.M. and a 0.5-mile setback from the bank's highest high watermark farther upstream.
f. Judy Creek: a 0.5-mile setback from the banks' ordinary high watermark.
g. Ublutuoch (TiJJmiaqsiugvik) River: a 0.5-mile setback from the ordinary high water mark.
h. Alaktak River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
i. Chipp River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
j. Oumalik River: a 0.5-mile setback from the Oumalik River ordinary high water mark from the mouth upstream to section 5, T8N, R14W, U.M., and a 0.5-mile setback in and above section 5, T8N, R14W, U.M.
k. Titaluk River: a 0.5-mile setback from the centerline. In Alternatives B-1 and B-2, the setback would be 2 miles from the centerline from its confluence with the Ikpikpuk River upstream through T7N, R12W, U.M.; above that point the setback would be the same as described above.
l. Kigalik River: a 0.5-mile setback from the ordinary high water mark.
m. Maybe Creek: a 0.5-mile setback from the ordinary high water mark.
n. Topagoruk River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
o. Ishuktak Creek: a 0.5-mile setback from the ordinary high water mark.
p. Meade River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark on
q. BLM-managed lands.
r. Usuktuk River: a 0.5-mile setback (1 mile for Alternative B-2) from the ordinary high water mark on BLM-managed lands.
s. Pikroka Creek: a 0.5-mile setback from the ordinary high water mark.
t. Nigisaktuvik River: a 0.5-mile (1 mile for Alternative B-2) setback from the Nigisakturik River ordinary high water mark upstream from the confluence with the Meade River to section 1, T11N, R25W, U.M. and a 0.5-mile setback further upstream.
u. Inaru River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
v. Kucheak Creek: a 0.5-mile setback from the ordinary high water mark.
w. Avalik River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark.
x. Niklavik Creek: a 0.5-mile setback from the ordinary high water mar*k*.
y. Kugrua River: a 0.5-mile setback from the ordinary high water mark.
z. Kungok River: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark on BLM-managed lands.

Note - NRPA BMP/ROPs listings beyond this point omitted as there is little application to the 1002 area, and as such, specific sensitive areas need to be identified with specific protective measures.

3a. TERRESTRIAL MAMMALS I: BEARS

Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.

a. Cross-country use of heavy equipment and seismic activity is prohibited within 0.5 mile of occupied grizzly bear dens identified by the ADF&G unless alternative protective measures are approved by the authorized officer in consultation with the ADF&G.
b. Cross-country use of heavy equipment and seismic activity is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators near coastal areas shall conduct a survey for potential polar bear dens and seal birthing lairs and consult with the FWS and/or NOAA, as appropriate, before initiating activities in coastal habitat between 30 Oct and 15 Apr.

3b. TERRESTRIAL MAMMALS II: CARIBOU (CAH/PCH)

Minimize disruption of caribou movement and subsistence use.

Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities. Listed below are the accepted design practices:

a. Above-ground pipelines shall be elevated a minimum of 7 feet as measured from the ground to the bottom of the pipeline at vertical support members.
b. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required by the authorized officer after consultation with Federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility).
c. A minimum distance of 500 feet between pipelines and roads shall be maintained. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the authorized officer.
d. Above-ground pipelines shall have a non-reflective finish.

3c. TERRESTRIAL MAMMALS III: OTHER SPECIES

Subsidized Predators: Avoidance of human-caused increases in populations of predators of ground-nesting birds.

a. Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the authorized officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites.
b. Feeding of wildlife is prohibited and will be subject to non-compliance regulations.

3d. WILDLIFE - GENERAL CONSIDERATIONS (multiple species)

Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.

The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines (Note - this BMP is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data):

a. Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within 0.5 mile of cliffs identified as raptor nesting sites from 15 Apr through 15 Aug and within 0.5 mile of known Gyrfalcon nest sites from 15 Mar to 15 Aug, unless doing so would endanger human life or violate safe flying practices. Permittees shall obtain information from the BLM necessary to plan flight routes when routes may go near falcon nests.
b. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from 1 Dec through 1 May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the authorized officer. The BLM will consult directly with the ADF&G in annually defining caribou winter ranges.
c. Land user shall submit an aircraft use plan as part of an oil and gas exploration or development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Proposed aircraft use plans should be reviewed by appropriate Federal, State, and borough agencies. Consultations with these same agencies will be required if unacceptable disturbance is identified by subsistence users. Adjustments, including possible suspension of all flights, may be required by the authorized officer if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility.
d. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum.
e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet AGL (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from 20 May through 20 Aug, unless doing so would endanger human life or violate safe flying practices. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area (Maps 2-3K or 2-4K) should be minimized from 20 May through 20 Aug, unless doing so would endanger human life or violate safe flying practices.
f. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet AGL (except for takeoffs and landings) over the Utukok River Uplands Special Area from 20 May through 20 Aug, unless doing so would endanger human life or violate safe flying practices.
g. Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away.
h. Fixed wing aircraft used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 2,000 feet and a 0.5-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices. Helicopters used as part of a BLM authorized activity along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices.
a. Aircraft used as part of a BLM-authorized activity along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet and a buffer of 1 mile from aggregations of seals, unless doing so would endanger human life or violate safe flying practices.

4. BIRDS

Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.

Illumination of all structures between 1 Aug and 31 Oct shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the FAA.

Minimize the take of bird species, particularly those listed under the Endangered Species Act and ~~BLM Special Status Species~~ FWS *Birds of Conservation Concern* (FWS 2008) from direct or indirect interaction with oil and gas facilities.

In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development.

Special Conditions in Spectacled and/or Steller's Eiders Habitats

a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the FWS North Slope eider survey area and at least 1 year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys. Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol. Information gained from these surveys shall be used to make infrastructure siting decisions as discussed in subparagraph b, below.
b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall work with the FWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, location of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and management of high noise levels.
c. To reduce the possibility of spectacled and/or Steller's Eiders colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases which are to be few in number and limited in extent. Exceptions are limited to the following situations, and must be reported to the FWS when exceptions are authorized:
    1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;
    2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or
    3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.
d. To reduce the likelihood of spectacled and/or Steller's Eiders colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the FWS.

Avoid and reduce temporary impacts to productivity from disturbance near Steller's and/or Spectacled Eider nests.

Ground-level activity (by vehicle or on foot) within 200 meters of occupied Steller's and/or Spectacled Eider nests, from 1 Jun through 15 Aug, will be restricted to existing thoroughfares, such as pads and roads. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 meters of occupied Steller's and/or spectacled eider nests will be prohibited. In instances where summer (1 Jun through 15 Aug) support/construction activity must occur off existing thoroughfares, FWS-approved nest surveys must be conducted during mid-June prior to the approval of the activity. Collected data will be used to evaluate whether the action could occur based on employment of a 200-meter buffer around nests or if the activity would be delayed until after mid-August once ducklings are mobile and have left the nest site. The BLM will also work with the FWS to schedule oil spill response training in riverine, marine, and inter-tidal areas that occurs within 200 meters of shore outside sensitive nesting/brood-rearing periods or conduct nest surveys. The protocol and timing of nest surveys for Steller's and/or Spectacled Eiders will be determined in cooperation with the FWS, and must be approved by the FWS. Surveys should be supervised by biologists who have previous experience with Steller's and/or Spectacled Eider nest surveys.

Special Conditions in Yellow-billed Loon Habitats

a. Aerial surveys shall be conducted by the lessee for at least 3 years before authorization of construction of facilities proposed for development which are within 1 mile of a lake 25 acres or larger in size. These surveys along shorelines of large lakes shall be conducted following accepted BLM protocol during nesting in late Jun and during brood rearing in late Aug.
b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a 1-mile buffer around all recorded nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.

Raptors: prevent or minimize the loss of nesting habitat for cliff nesting.

a. Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.

Raptors: prevent or minimize the loss due to electrocution by powerlines.

Comply with the most up-to-date industry-accepted suggested practices for raptor protection on powerlines. Current accepted standards were published in *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* (Avian Power Line Interaction Committee as updated and warranted).

Protections for Birds

a. To reduce the possibility of birds colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases, which are to be few in number and limited in extent. Exceptions are limited to the following situations:
   1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;
   2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or

    3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.

b. To reduce the likelihood of birds colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the FWS.

5. WILDERNESS RECREATIONAL VALUES

Manage permitted activities to meet Visual Resource Management (VRM) class objectives described below.

Class I: Natural ecological changes and very limited management activity are allowed. The level of change to the characteristic landscape should be very low and must not attract attention.
Class II: The level of change to the characteristic landscape should be low. Management activities may be seen, but should not dominate the view of the casual observer. Any changes should repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III: The level of change to the characteristic landscape should be moderate. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV: The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize impacts through location and design by repeating form, line, color, and texture.

At the time of application for construction of permanent facilities, the lessee/permittee shall, after consultation with the authorized officer, submit a plan to best minimize visual impacts, consistent with the VRM class for the lands on which facilities would be located. A photo simulation of the proposed facilities may be a necessary element of the plan.

6. RESTORATION AND REHABILITATION OF ABANDONED OILFIELDS

Ensure long-term reclamation of land to its previous condition and use.

Prior to final abandonment, land used for oil and gas infrastructure—including but not limited to well pads, production facilities, access roads, and airstrips—shall be reclaimed to ensure eventual restoration of ecosystem function. The leaseholder shall develop and implement an abandonment and reclamation plan approved by the BLM. The plan shall describe short-term stability, visual, hydrological, and productivity objectives and steps to be taken to ensure eventual ecosystem restoration to the lands' previous hydrological, vegetative, and habitat condition. The BLM may grant exceptions to satisfy stated environmental or public purposes.

NRPA IAP EIS (BLM 2012) 6Apr2018

SUMMARY OF MITIGATION RECOMMENDATIONS FOR THE COASTAL PLAIN 1002 AREA
[adapted from *Arctic National Wildlife Refuge, Alaska, Coastal Plain Resources Assessment: Report and Recommendation to the Congress of the United States and Final legislative Environmental Impact Statement* (Clough et al. 1987: 29 recommendations for oil and gas exploration, development, production, and transportation, pages 167-169)].

This does not include all mitigation measures for oil and gas exploration activities, nor climate change in the past 30 years; listing and critical habitat designation for polar bear; or cumulative impacts for the coastal plain environs.

Will these suffice for 2018 and beyond, possibly the next 30+ years based upon oilfield development history in the Arctic? Or is new information or studies necessary to amend these 29 or update with new recommendations?

	Mitigation Measure or Feature	Results - Consequence
1	Limit oil exploration, except surface geology studies, to Nov 1-May 1 (exact dates to be determined by Refuge Manager). Cease exploration activities & remove or store equipment at an approved site by May 15. Local exceptions may be made.	Will limit disturbance to periods when most fish & wildlife species are absent.
2	Consolidate, site, construct, & maintain facilities & pipelines to minimize effects on sensitive fish & wildlife habitats and species. Locate nonessential facilities outside concentrated caribou calving areas.	Will avoid or minimize disturbance in, or loss of, environmentally sensitive areas and allow free passage & natural movement of fish and wildlife.
3	Design all bridges and culverts to handle at least 50-year flood events.	Will prevent damage & disturbance of fish habitats.
4	Use ice or gravel-foam-timber pads, where feasible.	Will reduce gravel requirements & acres of habitat modified.
5	Prohibit: gravel removal from active stream channels on major fish-bearing rivers; winter water removal; from fish-bearing waters, or springs and tributaries feeding into fish-bearing waters; spring, summer, or fall water removal from fish-bearing waters to levels that will not easily pass fish or maintain quality rearing-habitat.	Will minimize disturbance to fish & degradation of fish habitats.
6	Elevate pipelines to allow free passage of caribou or place ramps or bury as feasible.	Will allow migration and other movements of caribou & large mammals.
7	Separate roads and pipelines 120-180 meters (400-800 feet), depending on terrain, in areas used for caribou crossing.	Will enhance crossing of linear structures by caribou & other mammals.
8	Construct docks and causeways so that fish movements are not impeded and lagoon water chemistry is basically unchanged.	Will provide for fish and marine mammal movement & lessen degradation of near-shore marine habitat.

9	Avoid construction in coastal areas near river systems with topographic relief or bluffs; otherwise, minimize construction activities along the coast, through the denning period, approximately mid-Mar annually. Minimize activities along the coast during late Oct-early Nov when polar bears* come ashore to den.	Will reduce disturbance to polar bears, and prevent destruction of potential bear den & raptor nest sites. * Polar bears listed with critical habitat identified since 1987.
10	Restrict surface occupancy in the zone from the coastline inland 4.8 kilometers (3.0 miles) to marine facilities & infrastructure essential to move inland beyond the restricted zone; drill pads & production facilities could be allowed within the zone 2.4-4.8 kilometers (1.5 to 3.0 miles) from the coast on a site-specific basis.	Will permit caribou use of coastal insect-relief habitat & reduce disturbance of nesting waterfowl and other species.
11	Prohibit surface occupancy in the Sadlerochit Spring Special Area (see page 19: 50 CFR § 37.32).	Will prevent degradation of a unique environment & prevent loss of water essential for fish overwintering.
12	Minimize surface occupancy in immediate vicinity of areas identified as supporting *Thlaspi arcticum**. Include information on identification & need for avoidance of *T arcticum* in all environmental orientation briefings.	Will prevent destruction of *Thlaspi arcticum*. * Note, taxonomic nomenclature change from *T arcticum to Noccaea arctica,* arctic pennycress (https://plants.usda.gov/core/profile?symbol=NOAR2); species far more common than previously determined.
13	Use bear-proof fencing around certain facilities; develop solid waste management plans; incinerate putrescible waste daily; prohibit wildlife feeding; institute employee education programs as appropriate.	Will minimize bear/human confrontations, & reduce attraction of & increases in scavenger populations.
14	Inventory project areas for cultural resources, evaluate resources, & implement mitigation to avoid or minimize impact.	Will preserve cultural resources (archeological & historic sites) to the maximum extent possible.
15	Prohibit off-road vehicle use within 8.0 kilometers (5 miles) of all pipelines, pads, roads, & other facilities, except by local residents engaged in traditional uses or if otherwise specifically permitted.	Will minimize disturbance to wildlife, reduce destruction of vegetation, & permit migration of large mammals.
16	Establish time and area closures or restrictions on certain surface activity such as exploration, vehicle movements, & other activity that can be reasonably rescheduled, in areas of wildlife concentration during muskox calving, Apr 15-Jun 5; caribou calving May 15-Jun 20; caribou insect harassment Jun 20-Aug 15; snow goose	Will protect species from disturbance during critical periods.

	staging Aug 20-Sep 27; & fish overwintering & spawning.	
17	Limit use of development infrastructure, roads, & airstrips to persons on official business.	Will reduce disturbance & human/wildlife interaction.
18	Reinject drilling muds, cuttings, & other wastes where geologically feasible. Remove hazardous wastes off refuge to an approved disposal site.	Will minimize areas needed for reserve pits & reduce potential for contaminant spills.
19	Close areas within 1.2 kilometers (0.75 miles) of high-water mark of specified water courses to permanent facilities & limit transportation crossings. Gravel removal may occur on a site-specific basis.	Will protect riparian habitat and reduce stream pollution and disturbance in an important and limited habitat.
20	Prohibit use of explosives or other noisy activities within 3.2 kilometers (2 miles) of raptor nest sites Apr 15-Aug 31 (Jun 1 if nest is unoccupied), unless specifically authorized by the FWS.	Will protect nesting peregrine falcons & other raptors from disturbance.
21	Prohibit ground level activity, permanent facilities, & long-term habitat alterations (material sites, roads, & airstrips) within 1.6 kilometers (1 mile) of known peregrine* or other raptor nest sites Apr 15-Aug 31 (Jun 1 if nest is unoccupied) unless specifically authorized.	Will protect nesting peregrine falcons & other raptors from disturbance. * Peregrine Falcon delisted since 1987.
22	Survey suitable habitat annually to locate nesting peregrines & other raptors.	Will avoid conflicts between development & nesting raptors.
23	Establish no-activity zone of at least 0.8 kilometer (0.5 mile) around any confirmed polar bear den.	Will prevent disturbance during denning.
24	Close area within 8 kilometers (5 miles) of development & associated infrastructure to hunting, trapping, & discharge of firearms, except for subsistence uses only, on a site-specific basis, where there will be major effects on those uses.	Will increase public safety and reduce direct mortality of caribou, muskoxen, bears, and waterfowl; lower disturbance and increase the likelihood of habituation by species encountering development; however, will result in negative effects to subsistence uses of some areas.
25	Develop and implement plans for control, use, and disposal of fuel and hazardous wastes.	Will reduce potential for contaminant spills.
26	Monitor populations, productivity, movements, & general health of key species. Research measures to further minimize adverse effects of development. Implement corrective actions.	Will allow early identification of problems & implementation of corrective measures for caribou, muskoxen, polar bears, snow geese, arctic char, & others.

27	Provide: environmental orientation briefings for workers; program for monitoring development activities; continuation of fish & wildlife population monitoring; follow-up programs to evaluate effects.	Will increase environmental awareness of workers; give managers continuing baseline information to analyze effects of development and improve protective measures; help to ensure effectiveness of mitigation.
28	Develop plans in conjunction with area residents & organizations to properly manage impacts on communities.	Will minimize undesirable sociocultural & socioeconomic impacts, such as chemical dependency, boom-&-bust cycle, & cultural disorientation.
29	Develop and implement an approved rehabilitation plan as part of the appropriate permit stages.	May provide total or partial restoration of habitat values in affected area.

jwm11Oct2017

Habitat BMPs: 1002 Area/Arctic Refuge

1. Bird nesting timing window (BNW) (June 1 to July 31) no gravel placement or tundra disturbance
2. Placement of gravel for roads and pads preferably placed in winter (or first layer placed in winter – see #4)
3. No overhead power lines (artificial next structures/perching for birds of prey); powerlines strung on VSMs or in utility cables in roads
4. Airstrips constructed outside the BNW. FAA often requests gravel placement in summer for compaction/safety. In these cases we recommend clearing (in any) and the first layer of gravel be placed in the entire footprint before the onset of BNW. Additional gravel layers then can be placed and compacted during BNW throughout summer
5. Culverts placed along long linear roads in sufficient number to prevent ponding of sheetflow and maintain natural flow throughout break-up and summer/fall rain events
6. Watering of roads during summer to prevent dust impacts along road (usually is insufficient)
7. Creeks and rivers crossed with bridges (spanning the entire drainage) or sufficiently-sized square-bottom culverts to allow for natural stream flow during break-up periods, flood-stage flows, and minimal flow (non-perched structures) and provide for fish passage.
8. Erosion control material (supersacks, revetment) placed on banks of river under and adjacent to bridges and adjacent to and on bottom of stream approach and exit of large culvers (when necessary) to prevent high-water erosion of road/pad and stream bottom.
9. Pipeline height at least 7 ft (at lowest point between VSMs)
10. Pipeline at least 300 ft. (preferably 500 ft.) from gravel road
11. Infrastructure should be placed inland from the coast to prevent collision risk to migrating birds. Lighting should be shielded from the east during fall migration.

Mine Site Development and Restoration: 1002 Area/Arctic Refuge

Mine Site Development:

- In general, the Service recommends the use of existing gravel mine sites rather than the development of new "individual, one-time only use" pits. Use of an existing cell is preferable. Opening a new cell within a permitted mine site is an option provided the cell is developed as a multi-use cell and is constructed with applicable BMPs.
- In the 1002 area we suggest a thorough survey of potential gravel sources prior to development. Need to decide potential layout of mine sites across the landscape.
- Gravel within the 1002 area is thought to be shallower and more available than in the oilfields to the west, although the quality of the gravel may differ depending where it is located.
- The Service suggests mine sites be developed with 3:1 or 2.5:1 side slopes if possible. Our North Slope experience has demonstrated mine pits with side slopes steeper than 3:1 are very unstable, prone to thermokarsting, erosion and eventual failure, usually within the first year of excavation. While we understand mining with 1:1 side slopes allows for a smaller footprint, the risk of side slope failure due to thermokarst and erosion, especially on south and west facing slopes, is greatly enhanced with steep slopes.
- The Service advises the placement of overburden along the top edge of the entire cell for safety reasons (winter travel via snow machine) and to insulate the sides from thermokarst/melting of ice wedges. Without this insulation exposed ice wedges will melt and erode back away from the edge of the pit in spring and summer with the potential to drain adjacent wetlands. Once erosion ensues it is very difficult and expensive to mitigate/repair.
- Upon opening a new cell, the Service requests organic soil be separated from the inorganic overburden and stored separately for vegetation rehabilitation projects. Alternatively, organic sod blocks can be harvested and stored for later restoration use.

Mine Site Restoration:

Mine site rehabilitation, to include the creation of wetlands and/or littoral areas on the North Slope is a long-term and expensive endeavor and in many situations has not been successful. Our North Slope experience has shown overburden material, when placed back into a pit to create shallows, does not subside or subsides too much, resulting in either perched piles of overburden or a deep pit with no littoral zone. In situations where overburden is limited (single cell pits) modification of the restoration plan may be especially difficult to accomplish. In addition, a pit may take 15 to 30 years to fill with water, depending upon its location. The Service therefore does not support the placement of inorganic overburden within the cell to create littoral areas.

The creation of overwintering fish habitat in deep mine sites adjacent to fish bearing streams has been accomplished within the oil fields. However, overwintering fish habitat is naturally limiting on the North Slope and has not been impacted due to infrastructure. While the Service does not

object to the creation of additional overwintering fish habitat within the oil fields we feel strongly that it should not compensate for the loss of wetland habitats associated with development. However, the creation of overwintering fish habitat within the 1002 Area may be controversial in that it would be altering the Refuge's natural balance and therefore be counter to the objectives of the Refuge.

North Slope mine site rehabilitation plans should include the following:

- The top edge of the entire cell should be bermed for safety and to prevent thermokarst and erosion;
- Side slopes should be at least 2.5:1 or preferably 3:1. Additional overburden should be placed along the side slopes if mined at a steeper gradient (i.e.: 1:1) to prevent erosion;
- The site should be monitored annually from spring breakup to fall freeze-up to ensure the stability of the slopes until the pit has stabilized with water;
- Once the pit has filled with water, berm material may be removed by pushing it onto the ice during winter.

From:	Twitchell, Hollis
To:	Berendzen, Steve
Cc:	Clark, Karen; Doug Damberg; Mitch Ellis
Subject:	Re: VIP visit/consultation with Arctic Village
Date:	Wednesday, April 11, 2018 12:19:45 PM

I can be available that day.

On Tue, Apr 10, 2018 at 5:34 PM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:

> Thanks for the heads up, Karen - I can be available that day. Did they say how they planned to get there, and if it would be an overnighter? I'm pretty sure that commercial flights still go there only once per day, and if that's the case we'd have to plan on spending the night which generally means sleeping on the floor in the school.
>
> Maybe they're considering a charter again?
>
> Steve Berendzen
> Refuge Manager, Arctic National Wildlife Refuge
> 907-456-0253
>
> On Tue, Apr 10, 2018 at 8:34 AM, Clark, Karen <karen_clark@fws.gov> wrote:
>
>> Hey there,
>>
>> Yesterday when meeting with Steve Wackowski, he requested assistance with a trip to Arctic Village that is currently planned for April 23. At Joe Balash's last visit, they didn't make it there and this is the follow-up. There are some flight approvals they are working through, so they may or may not need help with transportation. Either way, he would definitely like to have Hollis there. Steve, it also seems like a good idea for you to go along if you are available.
>>
>> I don't know any of the details other than the date, but figured I would start with checking availability first. Hollis and Steve, are you two available on April 23?
>>
>> Thanks, Karen
>>
>> Karen P. Clark
>> Deputy Regional Director
>> U.S. Fish & Wildlife Service- Alaska Region
>> 1011 E Tudor Rd, MS 374
>> Anchorage, AK 99503
>> karen_clark@fws.gov
>> 907.786.3542 office
>> 907.786.3493 direct
>> 907.786.3306 fax

--

Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From:	Twitchell, Hollis
To:	Steve Berendzen; Fox, Joanna
Subject:	Re: airlift/liaison support for Arctic village
Date:	Thursday, April 12, 2018 5:38:31 PM

Are they considered SES people and do they need to travel in twin engine aircraft, or are we expected to fly them ourselves? Not clear whether OAS are arranging their flights and from where. Appears to be just a day trip, no over night.

On Thu, Apr 12, 2018 at 2:38 PM, Karen Clark <karen_clark@fws.gov> wrote:

> Hi Steve,
> Both Hollis Twitchell and Steve Berendzen from Arctic Refuge are available to assist. They are copied on this email.
>
> Karen
>
> Sent from my iPhone
>
> On Apr 12, 2018, at 2:07 PM, Wackowski, Stephen <stephen_wackowski@ios.doi.gov> wrote:
>
>> Per our discussion ASLM Balash and I need to do our 1002 lease sale cooperation invite to folks in Arctic Village on 23 April.
>>
>> You had mentioned we have a pilot that is from the area that also could help show us around the village and introduce us to folks. Could you link us up?
>>
>> I think we just need to be in Arctic Village from 12:00-2pm on the 23rd. IOS Alaska office is the requester and will pay for the flight.
>>
>> Lesia will work the SOL and OAS official request--just wanted to put this on your radar ASAP.
>>
>> Thanks,
>>
>> Steve
>>
>> Steve Wackowski
>> Senior Adviser for Alaskan Affairs
>> Department of the Interior
>> 4230 University Drive, Suite 300
>> Anchorage, AK 99508
>> 907-271-5485

--
Hollis Twitchell

Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From:	Alice Garrett
To:	Berendzen, Steve
Cc:	Boario, Sara; Soto, Alfredo; Joanna Fox; Hollis Twitchell
Subject:	Re: request for information
Date:	Monday, April 16, 2018 8:38:18 AM

Thanks so much for everything Steve. Hoping to connect with him tomorrow to begin the process. For Kaktovik location (filming only in areas of refuge jurisdiction) we would like to tentatively look for the week of Sept. 17th. I want to give you and Sara as much heads up for that date range because of the number of elements involved. We will likely have 5 persons for the trip. I am requesting information from Hollis or others on boat operators to use for access options. Please let me know if you have questions or wish to discuss. In the meantime I will look to discuss with Alfredo regarding permitting needs.

Most Sincerely,
Alice

Sent from my iPad

On Apr 5, 2018, at 7:32 PM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:

> Thanks, Alice - I'm glad you connected with Sara on this. We're really backed up with things right now so I'll ask Alfredo, our permit specialist, to look at this and determine what additional information we need and start the process for the MRA. He should be able provide you some guidance along with questions for more info that we might need.
>
> Steve Berendzen
> Refuge Manager, Arctic National Wildlife Refuge
> 907-456-0253
>
> On Wed, Apr 4, 2018 at 10:30 AM, Garrett, Alice <alice_garrett@fws.gov> wrote:
>
>> Steve,
>>
>> Sara and I were able to talk last week regarding filming efforts for Alaska this year. She would like for us to check in with her POC for the Kaktovik portion and she would like for someone from her staff to be included in the filming effort in the wildness area. Understanding that these two pieces will likely take place at separate times I would like to talk with the appropriate person about making arrangements and reservations for both of these efforts. Please let me know what would be the proper procedure.
>>
>> As discussed for Kaktovik we would like to pursue filming on the refuge and designated waters, not in the village or in any areas that are considered sensitive or off limits. For the wilderness segment we would like to see what commercial operator we can make arrangements with to minimize requirements of refuge staff etc. I understand we will need to need to do a minimum tools assessment. I know we've discussed both of these aspects but would just like to be clear about intentions for the project.

Please let me know if you wish to discuss and also how we might proceed.

Hope all is well there.

Most Sincerely,
Alice

Alice Garrett
U.S. Fish and Wildlife Service
cell: 503.413.9589
email: alice_garrett@fws.gov

On Tue, Mar 20, 2018 at 8:22 PM, Berendzen, Steve <steve_berendzen@fws.gov> wrote:

> Alice,
>
> Thanks for the coordination and the phone message last week. I don't know if Hollis has gotten back to you with recommended boat and aircraft services, but we can offer suggestions for a few boat operators in Kaktovik and air taxi operators who work on the North Slope.
>
> I also wanted to let you know that our External Affairs folks from our regional office are interested in doing stories on Arctic NWR supported with film footage similar to what you're planning to do. There could be significant overlap between your intended product and what our regional office hopes to get. With all the attention that Arctic NWR is getting with the new legislation for the 1002 area, we're also looking carefully at activities that we are conducting as well as the messages that we're conveying to the public. I've copied Sara and Amee from our External Affairs office if you'd like to reply with more specifics on what your plans are for the summer trip in the 1002 and Wilderness portions of the refuge.
>
> Steve Berendzen
> Refuge Manager, Arctic National Wildlife Refuge
> 907-456-0253
>
> On Mon, Mar 19, 2018 at 8:29 AM, Garrett, Alice <alice_garrett@fws.gov> wrote:
>
>> Hollis,
>>
>> You, Steve, and Joanna were kind enough to speak to me a few weeks ago about filming at Arctic this summer/fall. I would like to know if you might be able to advise me on operators that you recommend for the segments we discussed. I'm looking for both aerial and boat ops that you would find appropriate. We are looking at approx. 4-5 people for both arrangements.
>>
>> Happy to discuss by phone is that is better. Thank you and hope you are well!
>>
>> Most Sincerely,
>> Alice

Alice Garrett
U.S. Fish and Wildlife Service
cell: 503.413.9589
email: alice_garrett@fws.gov

From: Churchwell, Roy
To: Fox, Joanna
Cc: Stephen Arthur; Christopher Latty
Subject: Re: Meetings with Conoco in April/May
Date: Tuesday, April 17, 2018 2:42:47 PM

Hello Joanna,

I was hoping to attend, but tomorrow is going to be a busy day for us. We are pulling all of the traps on our trap line. So, I won't be able to make it.

Roy

On Tue, Apr 17, 2018 at 9:53 AM, Fox, Joanna <joanna_fox@fws.gov> wrote:

> If you are interested in attending Conoco's avian environmental studies discussion tomorrow, we've been informed that it will start at 8:30am (rather than 9am, as originally scheduled). If you go in person, they're being held in the Arctic Conference Room at BLM. You can also join via BLM's phone bridge at [redacted] Passcode [redacted]
>
> ___________________________
>
> Joanna L. Fox
> Deputy Refuge Manager
> Arctic National Wildlife Refuge
> 101 12th Avenue, Room 236
> Fairbanks, AK 99701
> (907) 456-0549
>
> Follow us on Facebook!
> www.facebook.com/arcticnationalwildliferefuge
>
> *"Do what you can, with what you have, where you are." -- Theodore Roosevelt*
>
> ---------- Forwarded message ----------
> From: **Jones, Nichelle (Shelly)** <njones@blm.gov>
> Date: Wed, Mar 21, 2018 at 11:05 AM
> Subject: Meetings with Conoco in April/May
> To: Steve Berendzen <steve_berendzen@fws.gov>, "Fox, Joanna" <joanna_fox@fws.gov>
>
> Hello Steve and Joanna: Conoco will be coming up to Fairbanks almost every Wed. in April and half of May with their contractors to discuss their environmental studies with the Arctic District staff as follows:
>
> April 4 – Hydrology and Fisheries (combined as these resources are closely tied) 9:00am to 12:30pm
> April 11 – Caribou 1:30pm to 3:30pm
> April 18 – Avian 9am – 11am
> **April 25 – Cultural Resources/Archaeology 9am – 11am New!**
> May 2 - Ecological Land Survey, Integrated Terrain Unit Mapping, Rare Plant Surveys 9am to 11am
> May 9 – skip a week, open date
> **May 16 – Subsistence 9am – 12pm New!**
>
> All meetings will be held in our Arctic Conference Room here at the BLM Office in Fairbanks. Some of the dates may be subject to change, but most are starting to lock in.

> The purpose is to report on the monitoring they do, as required by stipulations attached to the authorizations they have from BLM and other agencies. Geographically, it is targeting primarily the Fish Creek watershed within the NPR-A. This is where their GMT-1 and GMT-2 developments are located.
>
> I got approval from Conoco to invite the Arctic Refuge staff to attend these sessions with us. I think it might be helpful in different ways and give you some ideas about future projects or information that might be helpful to permitting oil and gas activities in the future within the Coastal Plain. We might also have time to discuss additional data sets or follow up with you on ideas you might have for future monitoring work.
>
> Hope to see some of you here!
>
> -Shelly
>
> Shelly Jones
> Acting Manager
> Arctic District Office
> 222 University Avenue
> Fairbanks, AK 99709
>
> (907) 474-2310 (w)
> (907) 460-0086 (c)

--
Roy Churchwell, PhD
Wildlife Biologist
US Fish and Wildlife Service
Kanuti National Wildlife Refuge
101 12th Ave. Room 206
Fairbanks, AK 99701
(907) 456-0450
https://www.fws.gov/refuge/kanuti/

From:	Twitchell, Hollis
To:	Miriam (Nicole) Hayes; Wendy Loya; Fox, Joanna; Steve Berendzen; Doug Damberg
Subject:	Re:Tribal Contacts
Date:	Wednesday, April 18, 2018 6:10:55 PM

Nicole wrote asking:

Is Arctic Village Council the same as Arctic Village Traditional Council? Same with Venetie Village Council? Should there be separate levels to the Native Village of Fort Yukon and the Gwitchyaa Zhee Gwich'in Tribal Government or is it one in the same? Same with Naqsragmiou Tribal Gov't and Village of Anaktuvuk Pass. In other references they are referenced as Gwitchyaa Zhee Gwich'in Tribal Gov't/Native Village of Fort Yukon.

Do you have contacts for Village of Arctic Village, Native Village of Nuiqsut, Native Village of Stevens, and Native Village of Barrow?

Thanks for your help with this.
Nicole

Nicole Hayes
Project Coordinator
Bureau of Land Management
222 W. 7th Avenue #13
Anchorage, Alaska 99513
Desk: (907) 271-4354

Nicole, to answer your questions:

The villages of Venetie and Arctic Village each have their own Native Village Councils and we consult with each of them individually. Each Village Council is responsible for management decisions within that particular village community. Both villages are located within the former Venetie Indian Reservation (now known as "Venetie Tribal Lands") since they opted out of the Alaska Native Claims Settlement Act in order to retain their full land estate. There is no ANCSA corporation structure in these villages.

Both Venetie and Arctic Village communities belong to the Native Village of Venetie Tribal Government. Four members of the Tribal Council live in Venetie and four members of the Tribal Council live in Arctic Village. Out of respect and to meet our DOI/FWS consultation mandates, Arctic Refuge formally consults on a regular bases with each of these Councils (villages and tribal). However, only the Native Village of Venetie Tribal Government is recognized as a Federal Tribe for Government to Government consultation purposes.

In Fort Yukon, we formally consult with the Gwitchyaa Zhee Gwich'in Tribal Government on a Government to Government bases, and informally consult with the Council of Athabascan Tribal Governments. We have not been consulting with the Native Village of Fort Yukon.

Because of the significant distances between Arctic Refuge and Stevens Village, Nuiqsut, Anaktuvuk Pass, Barrow and Beaver, we do not routinely consult with these villages unless they request us to meet with them. We have on several occasion formally consult with Barrow and ICAS upon their requests when significant issues needed to be address such as the Refuge's Comprehensive Conservation Plan or the FWS National and Alaska Native Relations Policies.

When there is a substantive issue to be addressed we contact all Native organizations or councils (local or otherwise) and inquire what level of communication, involvement, or consultation either formal or informal they would like to have. Tribes and Councils have many demands upon them and often are short staffed, best to let them tell you what fit their needs best.

--
Hollis Twitchell

Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From: Twitchell, Hollis
To: Fox, Joanna; Steve Berendzen
Subject: Fwd: Arctic Village visit
Date: Wednesday, April 18, 2018 7:12:57 PM

Steve W called me mid-afternoon to say he had conversions with Tiffany about the April 23 meeting. Tiffany had called Steve W to cancel and reschedule the meeting to a later date. Steve explained to Tiffany that their intention was a casual meet and greet meeting with no formal action request from the community. Steve said Tiffany was going to talk again with the Village Council leadership and ask again about continuing with the April 23 meeting. Steve W said he would call me back in about an hour with a answer whether the meeting is going to happen on the 23rd. It's now been over three hours and no call back or email from Steve W yet. So it's still unknown to me.

Steve W also stated they tentatively planned for a formal meeting in Arctic Village on May 23rd, and asked about lodging or meals. Told him about the limited visitor services available in Arctic Village and Venetie and the protocols we use for conducting both business and respectful community relations with our village communities. He listened.

Told Steve W, if the meeting is still on for the 23rd, the long range weather forecasts look favorable and the plane is ready to go. If they wish that earlier departure time of 9:00 am, it would work fine. Steve W also said it was alright to share his email to Tiffany with you. Staying finely tune to the waiting game, however, I will be out of the office for portions of tomorrow going to a PRE-RETIREMENT SEMINAR.

---------- Forwarded message ----------
From: **Wackowski, Stephen** <stephen_wackowski@ios.doi.gov>
Date: Wed, Apr 18, 2018 at 1:36 PM
Subject: Fwd: Arctic Village visit
To: Hollis Twitchell <hollis_twitchell@fws.gov>

FYI

Steve Wackowski
Senior Adviser for Alaskan Affairs
Department of the Interior
4230 University Drive, Suite 300
Anchorage, AK 99508
907-271-5485

---------- Forwarded message ----------
From: **Wackowski, Stephen** <stephen_wackowski@ios.doi.gov>
Date: Wed, Apr 18, 2018 at 5:35 PM
Subject: Arctic Village visit
To: av_council@hotmail.com, tiffany_tritt_99722@hotmail.com

Tiffany-

My apologies for not being more clear in our intent of the visit this Monday. We will have no formal action requests from the community in this meeting. We want to take the extra step of visiting the village and introducing ourselves to the community before the formal 10-02 lease sale environmental study process starts. While both Joe and I are Alaskans, we have never

been to Arctic Village and we want to start the study process leaders/elders of the tribe and community having the opportunity to meet us in person beforehand.

The only formal action we would like to take is to hand deliver the consultation invite letter to First Chief John in person. We did that with Kaktovik's tribal president Eddie Rexford two weeks ago and want to show the same deference to Arctic Village's leadership. 99% of the time these letters are mailed but we wanted to show the respect of coming up to the village to hand deliver.

If possible we would like to have lunch there, tour the village, and meet some of the elders.

The formal NEPA visits for the 10-02 will begin in late May or early June. Asst. Secretary Balash will not be back up in Alaska before then. So this Monday would be the only opportunity for our trip until the formal meetings start.

My Best,

Steve

Steve Wackowski
Senior Adviser for Alaskan Affairs
Department of the Interior
4230 University Drive, Suite 300
Anchorage, AK 99508
907-271-5485

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From:	Twitchell, Hollis
To:	Fox, Joanna; Steve Berendzen
Subject:	Fwd: [EXTERNAL] Re: Arctic Village visit
Date:	Wednesday, April 18, 2018 8:13:03 PM

Breaking new flash.

---------- Forwarded message ----------
From: **Twitchell, Hollis** <hollis_twitchell@fws.gov>
Date: Wed, Apr 18, 2018 at 6:12 PM
Subject: Re: [EXTERNAL] Re: Arctic Village visit
To: "Wackowski, Stephen" <stephen_wackowski@ios.doi.gov>

Hi Steve, it seem quite clear from the attached Arctic Village Council letter that their preference and recommendation is for you and the Assistant Secretary Land and Minerals Management to attend the April 26th joint Arctic Village Council and Native Village of Venetie Tribal Government meeting in Venetie. Here's why:

The villages of Venetie and Arctic Village each have their own local Native Village Councils who are responsible for the management decisions in and around that particular village community. However, both Venetie and Arctic Village are located within the former Venetie Indian Reservation (now known as "Venetie Tribal Lands") since they opted out of the Alaska Native Claims Settlement Act in order to retain their full land estate of the former reservation. Both Venetie and Arctic Village members belong to the Native Village of Venetie Tribe.

The Native Village of Venetie Tribal Government's Council consists of four members living in Venetie and four members living in Arctic Village. Out of respect and to meet our DOI/FWS consultation mandates, Arctic Refuge formally consults on a regular bases with each of these Councils (villages and tribal). However, only the Native Village of Venetie Tribal Government is recognized as a Federal Tribe for Government to Government for the formal consultation purposes.

Arctic Village Council's recommendation that you to consider meeting with them in Venetie with the joint councils is valid. I know it would be inconvenient for you and Joe to change your plans and travel arrangement on such short notice, but it does make sense. It is not uncommon for these joint council meetings to request Arctic Refuge's presence to discuss specific topics.

If you still want to go to Arctic Village on the 23rd, I would be happy to fly you, but as Tiffany says, most of the key leaders will not be present there on that day. Just let me know your desires.

On Wed, Apr 18, 2018 at 4:24 PM, Wackowski, Stephen <stephen_wackowski@ios.doi.gov> wrote:

> Hollis- Let me know your thoughts on whether or not we should still go. -Steve
>
> Steve Wackowski
> Senior Adviser for Alaskan Affairs
> Department of the Interior
> 4230 University Drive, Suite 300
> Anchorage, AK 99508
> 907-271-5485

---------- Forwarded message ----------
From: Arctic Village Council <av_council@hotmail.com>
Date: Wed, Apr 18, 2018 at 7:56 PM
Subject: [EXTERNAL] Re: Arctic Village visit
To: "Wackowski, Stephen" <stephen_wackowski@ios.doi.gov>, "tiffany_tritt_99722@hotmail.com" <tiffany_tritt_99722@hotmail.com>, "kwilliams@hobbsstraus.com" <kwilliams@hobbsstraus.com>, Tonya Garnett <tonyagarnett@hotmail.com>, "myethumma@yahoo.com" <myethumma@yahoo.com>, Lance Whitwell <lancewhitwell@yahoo.com>

Steve,

Here you go please let me know?

Thank you

Tribal Administrator

Tiffany Yatlin

Arctic Village Council
P.O. Box 22069
Arctic Village, Alaska 99722

Phone 907-587-5523
Fax 907-587-5128
Email av_council@hotmail.com

From: Wackowski, Stephen <stephen_wackowski@ios.doi.gov>
Sent: Wednesday, April 18, 2018 1:35 PM
To: av_council@hotmail.com; tiffany_tritt_99722@hotmail.com
Subject: Arctic Village visit

Tiffany-

My apologies for not being more clear in our intent of the visit this Monday. We will have no formal action requests from the community in this meeting. We want to take the extra step of visiting the village and introducing ourselves to the community before the formal 10-02

> lease sale environmental study process starts. While both Joe and I are Alaskans, we have never been to Arctic Village and we want to start the study process leaders/elders of the tribe and community having the opportunity to meet us in person beforehand.
>
> The only formal action we would like to take is to hand deliver the consultation invite letter to First Chief John in person. We did that with Kaktovik's tribal president Eddie Rexford two weeks ago and want to show the same deference to Arctic Village's leadership. 99% of the time these letters are mailed but we wanted to show the respect of coming up to the village to hand deliver.
>
> If possible we would like to have lunch there, tour the village, and meet some of the elders.
>
> The formal NEPA visits for the 10-02 will begin in late May or early June. Asst. Secretary Balash will not be back up in Alaska before then. So this Monday would be the only opportunity for our trip until the formal meetings start.
>
> My Best,
>
> Steve
>
> Steve Wackowski
> Senior Adviser for Alaskan Affairs
> Department of the Interior
> 4230 University Drive, Suite 300
> Anchorage, AK 99508
> 907-271-5485

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From: Hayes, Miriam (Nicole)
To: Fox, Joanna
Cc: Wendy Loya; Steve Berendzen; Doug Damberg; Twitchell, Hollis; Drew Crane
Subject: Re: Tribal Contacts
Date: Thursday, April 19, 2018 2:49:05 PM

Thank you, Joanna.
Nicole

Nicole Hayes
Project Coordinator
Bureau of Land Management
222 W. 7th Avenue #13
Anchorage, Alaska 99513
Desk: (907) 271-4354

On Thu, Apr 19, 2018 at 12:44 PM, Fox, Joanna <joanna_fox@fws.gov> wrote:

> Good morning Nicole,
>
> Following are the contacts I have for the Arctic Village Council, Stevens Village IRA Tribal Council, and Native Village of Barrow :
>
> Arctic Village Council
> Johnathan John, First Chief
> P.O. Box 22069
> Arctic Village, AK 99722
>
> Stevens Village IRA Tribal Council
> Michael Simon, First Chief
> P.O. Box 16
> Stevens Village 99774
>
> Native Village of Barrow Inupiat Traditional Government
>
> P.O. Box 1130
> Utqiagvik, AK 99723
>
> We have not worked or consulted with the Native Village of Nuiqsut, so I do not have any contact information for them. I also don't have a current contact for the Native Village of Barrow Inupiat Traditional Government, as we have worked more closely with the North Slope Borough and the North Slope Regional Advisory Council - not the tribal government there.
>
> Thank you,
> Joanna
>
> ______________________________
> Joanna L. Fox
> Deputy Refuge Manager
> Arctic National Wildlife Refuge
> 101 12th Avenue, Room 236
> Fairbanks, AK 99701
> (907) 456-0549

Follow us on Facebook!
www.facebook.com/arcticnationalwildliferefuge

“Do what you can, with what you have, where you are.” -- Theodore Roosevelt

On Wed, Apr 18, 2018 at 4:03 PM, Twitchell, Hollis <hollis_twitchell@fws.gov> wrote:

Nicole wrote asking:

Is Arctic Village Council the same as Arctic Village Traditional Council? Same with Venetie Village Council? Should there be separate levels to the Native Village of Fort Yukon and the Gwitchyaa Zhee Gwich'in Tribal Government or is it one in the same? Same with Naqsragmiou Tribal Gov't and Village of Anaktuvuk Pass. In other references they are referenced as Gwitchyaa Zhee Gwich'in Tribal Gov't/Native Village of Fort Yukon.

Do you have contacts for Village of Arctic Village, Native Village of Nuiqsut, Native Village of Stevens, and Native Village of Barrow?

Thanks for your help with this.
Nicole

Nicole Hayes
Project Coordinator
Bureau of Land Management
222 W. 7th Avenue #13
Anchorage, Alaska 99513
Desk: (907) 271-4354

Nicole, to answer your questions:

The villages of Venetie and Arctic Village each have their own Native Village Councils and we consult with each of them individually. Each Village Council is responsible for management decisions within that particular village community. Both villages are located within the former Venetie Indian Reservation (now known as "Venetie Tribal Lands") since they opted out of the Alaska Native Claims Settlement Act in order to retain their full land estate. There is no ANCSA corporation structure in these villages.

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In Fort Yukon, we formally consult with the Gwitchyaa Zhee Gwich'in Tribal Government on a Government to Government bases, and informally consult with the Council of Athabascan Tribal Governments. We have not been consulting with the Native Village of Fort Yukon.

Because of the significant distances between Arctic Refuge and Stevens Village, Nuiqsut, Anaktuvuk Pass, Barrow and Beaver, we do not routinely consult with these villages unless they request us to meet with them. We have on several occasion formally consult with Barrow and ICAS upon their requests when significant issues needed to be address such as the Refuge's Comprehensive Conservation Plan or the FWS National and Alaska Native Relations Policies.

When there is a substantive issue to be addressed we contact all Native organizations or councils (local or otherwise) and inquire what level of communication, involvement, or consultation either formal or informal they would like to have. Tribes and Councils have many demands upon them and often are short staffed, best to let them tell you what fit their needs best.

> > --
> > Hollis Twitchell
> > Assistant Manager
> > Arctic Refuge
> > 907 456-0512 w
> > 907 378-5732 c

From:	Twitchell, Hollis
To:	Fox, Joanna; Steve Berendzen; Miriam (Nicole) Hayes
Subject:	Utqiagvik or Barrow Tribal Gov
Date:	Thursday, April 19, 2018 3:08:02 PM

The **Native Village of Barrow Inupiat Traditional Government** (previously, *Native Village of Barrow*) is a U.S. federally recognized Alaska Native Inupiat "*tribal entity*", as listed by the Bureau of Indian Affairs. Located in Utqiagvik, Alaska, it is part of the North Slope Borough. The constitution and by-laws of the native village were established in 1940 under the Indian Reorganization Act (IRA) of 1934. Thomas Olemaun, is the Executive Director and Council President of the Native Village of Barrow Inupiat Traditional Government. Primary phone: (907) 852-4411. Fax: (907) 852-8844.

Back in the office for

--
Hollis Twitchell
Assistant Manager
Arctic Refuge
907 456-0512 w
907 378-5732 c

From:	Steve Berendzen
To:	Karen Clark
Cc:	sara_boario@fws.gov; amee_howard@fws.gov; Joanna_fox@fws.gov; Hollis_Twitchell@fws.gov; gregory_siekaniec@fws.gov
Subject:	Re: this upcoming week
Date:	Friday, April 20, 2018 11:47:25 AM

Thanks for the heads up, Karen - we'll be sparse on staff, but this should be informative for those who can attend

Sent from my iPhone

On Apr 20, 2018, at 10:14 AM, Karen Clark <karen_clark@fws.gov> wrote:

> FYI
>
> Karen P. Clark
> Deputy Regional Director
> U.S. Fish & Wildlife Service- Alaska Region
> karen_clark@fws.gov
> 907.786.3542 office
> 907.786.3493 direct
> 907.786.3306 fax
>
> Begin forwarded message:
>
>> **From:** "Wackowski, Stephen" <stephen_wackowski@ios.doi.gov>
>> **Date:** April 20, 2018 at 9:12:26 AM AKDT
>> **To:** Karen Mouritsen <kmourits@blm.gov>, James Kendall <james.kendall@boem.gov>, David Johnston <david.johnston@boem.gov>, Ted Murphy <t75murph@blm.gov>, "Gieryic, Michael" <mike.gieryic@sol.doi.gov>, Greg Siekaniec <greg_siekaniec@fws.gov>, Kevin Pendergast <kevin.pendergast@bsee.gov>, Mark Fesmire <mark.fesmire@bsee.gov>, Karen Clark <karen_clark@fws.gov>
>> **Subject: Fwd: this upcoming week**
>>
>> Flagging for you all so you are aware
>>
>> Greg/Karen- We may be getting in touch to schedule a visit to the Arctic Refuge office to meet the team.
>>
>> -Steve
>>
>> Steve Wackowski
>> Senior Adviser for Alaskan Affairs

Department of the Interior
4230 University Drive, Suite 300
Anchorage, AK 99508
907-271-5485

---------- Forwarded message ----------
From: Wackowski, Stephen <stephen_wackowski@ios.doi.gov>
Date: Fri, Apr 20, 2018 at 1:05 PM
Subject: this upcoming week
To: Lesia Monson <lesia_monson@ios.doi.gov>

As you saw we had to push our Arctic Village visit from Monday to Thursday to Venetie.

ASLM is going to be in Alaska Mon-Thursday now and we are working
today to schedule some DOI site visits.

I'd expect us to be between Anchorage and Fairbanks.

More to follow soon.

Steve Wackowski
Senior Adviser for Alaskan Affairs
Department of the Interior
4230 University Drive, Suite 300
Anchorage, AK 99508
907-271-5485

BISON CONNECT

Brown, Randy <randy_j_brown@fws.gov>

Fwd: May 3 Internal 1002 Scoping Mtg

1 message

Brown, Randy <randy_j_brown@fws.gov> Mon, Apr 23, 2018 at 11:05 AM
To: Matt Whitman <MWhitman@blm.gov>

Hey Matt,
I go on leave to see my younger son graduate law school back in Virginia immediately following this meeting on the 3rd. I assume you will be the point fish person for BLM interacting with the consulting firm. Just in case I'm not around to respond to requests for information while I'm gone (about a week), I'm sending you both of the fishes profiles I prepared earlier this winter, the draft with all the species profiles and references, and the simplified one that just has broad summaries and no references. I will be at the meeting on the 3rd.
Later,
Randy
---------- Forwarded message ----------
From: **Crane, Drew** <drew_crane@fws.gov>
Date: Mon, Apr 23, 2018 at 10:29 AM
Subject: Save the Date - May 3 Internal 1002 Scoping Mtg
To: Ted Swem <ted_swem@fws.gov>, Angela Matz <angela_matz@fws.gov>, Ryan Wilson <ryan_r_wilson@fws.gov>, Randy Brown <randy_j_brown@fws.gov>
Cc: Sarah Conn <sarah_conn@fws.gov>, Patrick Lemons <patrick_lemons@fws.gov>, Mary Colligan <mary_colligan@fws.gov>

Hi All,

In addition to the announcement of the scoping notice for the 1002 EIS, BLM has also awarded a contract to a consultant to help develop the document. As a part of the contract, an internal scoping meeting with BLM and FWS will be held on May 3. A location and time have not been identified yet, but an invitation will be sent out once they are. As members of the IDT team from FES that we put forward, you are encouraged to attend this meeting. I will forward any additional information that I receive on this.

Thanks,

Drew Crane
Regional Endangered Species Coordinator
Alaska Region
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503
907-786-3323

--
Randy J. Brown
Fishery Biologist
U.S. Fish and Wildlife Service
101 12th Ave., Room 110
Fairbanks, Alaska 99701

Phone: (907) 456-0295
E-mail: <randy_j_brown@fws.gov>

2 attachments

1002Area_FishSection_ComprehensiveReferenced_021518.docx
78K

FishesSection_Feb15_2018_SimplifiedTemplate.docx
25K

Fisheries

Overview

The eastern North Slope in Alaska is endowed with limited freshwater options for fish. As a result, there are only a few species that occupy the freshwater habitats that are available. Lake density is very low in the 1002 Area, east of the Canning River drainage, but increases progressively to the west (White et al. 2008; Arp and Jones 2009). Several mountain streams cross the 1002 Area between the Canning and Aichilik rivers (Craig and McCart 1975). These streams flow during summer with snowmelt, rainfall, perennial springs, and for some streams, melting glaciers (Craig and McCart 1975; Rabus and Echelmeyer 1998; Kane et al. 2013), however, only the perennial springs provide flow during winter (Craig and McCart 1975). Craig (1989a) estimated that winter habitat in the area was only about 5% of what was available for fishes during summer.

The nearshore environment in the southern Beaufort Sea, adjacent to the 1002 Area, is a mix of open coast and lagoons bounded by barrier islands. In summer, water along the coast becomes brackish and relatively warm because of flow from the Mackenzie River and other rivers along the eastern Arctic coastline (Craig 1984; Hale 1991; Dunton et al. 2006). The lagoons are relatively shallow, the amplitude of the tides is very small (≤30 cm), barrier islands restrict flow to some extent, and the environment becomes much less salty and much warmer than sea water outside the barrier islands. The lagoons are very productive environments for marine and anadromous species during summer. In winter, in part because of reduced flow between lagoons and the sea, and in part because of ion exclusion during ice formation, some lagoons become hypersaline environments that get even colder than normal sea water under ice. As winter approaches and the lagoons begin freezing up, anadromous fishes return to freshwater environments and marine fishes eventually retreat to offshore environments.

Freshwater species present in the 1002 Area include Dolly Varden *S. malma*, Arctic grayling *Thymallus arcticus*, round whitefish *Prosopium cylindraceum*, burbot *Lota lota*, and ninespine stickleback *Pungitius pungitius* (Fruge and Palmer 1994). Round whitefish and burbot are present in the Canning River but nowhere else in the 1002 Area (Craig 1977c; Fruge and Palmer 1994). Dolly Varden are present in three life history forms: anadromous populations in which most members rear in freshwater rivers for 2–4 years then begin migrating to sea to feed each summer; residual dwarf males of the anadromous populations that choose to stay in freshwater rivers rather than migrate to sea; and dwarf resident populations that exist in isolated lakes or perennial springs (McCart and Craig 1973; Craig 1977c; Craig 1978). Arctic grayling occur in some lakes and also in rivers with perennial springs that are used for overwintering habitat (Craig and McCart 1974; Fruge and Palmer 1994). Ninespine stickleback occur as both freshwater residents and as anadromous forms. They are common in lakes and the lower reaches of many rivers and streams throughout the 1002 Area.

Anadromous species known to occur in or adjacent to the 1002 Area include Dolly Varden, ninespine stickleback, Arctic cisco *Coregonus autumnalis*, broad whitefish *C. nasus*, humpback whitefish *C. clupeaformis*, least cisco *C. sardinella*, chum salmon *Oncorhynchus keta*, pink salmon *O. gorbuscha*, Chinook salmon *O. tshawytscha*, and rainbow smelt *Osmerus mordax* (Craig 1984; Fruge and Palmer 1994; Brown 2008). Dolly Varden and ninespine

stickleback are the only anadromous species in this group that maintain populations within the rivers of the 1002 Area. Dolly Varden are known to migrate long distances along the coast during their summer feeding forays, east to the Mackenzie River and west to the Colville River or beyond (Kruger et al. 1999), and some individuals migrate into offshore waters as well (Courtney et al. 2018). Arctic cisco have natal origins in the Mackenzie River but disperse as juveniles to coastal habitats including the Colville River delta, where many overwinter in brackish environments (Galloway et al. 1983; Fechhelm et al. 2007). Rearing Arctic cisco make annual feeding migrations along shore during summer and eventually return to the Mackenzie River to spawn. Broad whitefish, humpback whitefish, and least cisco that are encountered in nearshore environments adjacent to the 1002 Area have natal origins in either the Mackenzie River to the east or the Sagavanirktok or Colville rivers to the west (Craig 1984). Salmon species that occur in nearshore waters adjacent to the 1002 Area or in rivers within the 1002 Area are thought to be strays from southern Chukchi or northern Bering Sea populations, although some believe that self-sustaining chum salmon populations may exist in the Mackenzie River drainage (Stephenson 2006; Irving et al 2009). Rainbow smelt are known to spawn in the Mackenzie and Colville rivers as well as in the Kuk River drainage farther west (Craig 1984). Dolly Varden and Arctic cisco are the primary food fishes for people in north east Alaska (Craig 1989b; Pederson and Linn 2005).

There are about 12 species of marine fishes that are commonly encountered in nearshore brackish environments adjacent to the 1002 Area, only four of which are relatively abundant during the summer season (Craig 1984; Brown 2008). These are fourhorn sculpin *Myoxocephalus quadricornis*, Arctic flounder *Pleuronectes glacialis,* saffron cod *Eleginus gracilis*, and Arctic cod *Boreogadus saida*. While anadromous species tend to migrate along shore in the southern Beaufort Sea, marine species are thought to follow a very different migratory pattern; moving towards shore and into shallow water during summer and away from shore and into deeper water during winter (Craig 1984). It is not uncommon to find these four common marine species in brackish environments during summer, or even in the very lower reaches of the rivers in the area.

Species accounts

Some of the fish species of ecological and/or subsistence value in or adjacent to the Arctic NWR are discussed below. Information about distribution, life history characteristics, and subsistence use is presented when available.

Broad whitefish *Coregonus nasus* are large, primarily benthic-feeding whitefish found in many Arctic and sub-Arctic waters of Asia and North America (McPhail and Lindsey 1970; Morrow 1980). They are present but uncommon in the nearshore waters of the Beaufort Sea adjacent to the 1002 Area (Craig 1984; Brown 2008). Broad whitefish populations may exhibit either anadromous or freshwater resident life histories (Reist and Bond 1988; Chudobiak 1995; Brown et al. 2007). Because rivers flowing through the 1002 Area do not support spawning or overwintering habitats for broad whitefish, they spawn and overwinter in aquatic habitats in the lower Sagavanirktok River and farther west, or in the Mackenzie River and farther east (Craig 1984, 1989a; Reist and Bond 1988). Therefore, all broad whitefish encountered in or adjacent to the 1002 Area are anadromous fish foraging in nearshore and estuarine habitats of the Beaufort

Sea and occasionally in the lower reaches of the larger rivers (Ward and Craig 1974; Craig 1984; Brown 2008).

Age at maturity for broad whitefish ranges from about five years old for the earliest maturing populations, such as those in the Peel (VanGerwen-Toyne et al. 2008) and Yukon (Carter 2010) rivers, to about eight years old for the latest maturing populations, such as those in the Selawik River in western Alaska (Brown 2004) and in the Teshekpuk Lake region in northern Alaska (Moulton et al. 2007). Broad whitefish spawn in flowing water over gravel in late October and November (Chang-Kue and Jessop 1997; Shestakov 2001; Carter 2010), which is three to four weeks later than other whitefish species. They survive spawning and may spawn multiple times during their lives. Once mature, spawning may be annual (Tallman et al. 2002) or less frequently (Prasolov 1989; Brown 2004). Broad whitefish are capable of living for 20 years or more (Brown 2004; VanGerwen-Toyne et al. 2008), and the oldest individuals in a population may exceed 30 years (Bond and Erickson 1985; Reist and Bond 1988). Broad whitefish are a very good food fish (McPhail and Lindsey 1970; Morrow 1980) and are harvested at times in nearshore waters adjacent to the 1002 Area (Pedersen and Linn 2005).

Humpback whitefish *Coregonus clupeaformis* are medium size, primarily benthic-feeding whitefish that are widely distributed in rivers, lakes, and estuaries of northern North America (McPhail and Lindsey 1970). Many similar forms have been described across North American and Asia and substantial taxonomic debate continues regarding appropriate species designations (Lindsey 1963; Alt 1979; Bodaly et al. 1988; Bernatchez and Dodson 1994). McPhail and Lindsey (1970) considered humpback whitefish to be part of a complex of three species that included *C. clupeaformis*, *C. pidschian*, and *C. nelsoni*, distinguished based on slight differences of modal gill raker counts on the first gill arch. A recent meristic, morphometric, and genetics analysis of the three humpback whitefish forms across North America concluded that the complex should be considered a single species, *C. clupeaformis*, differentiated at the subspecies level (McDermid et al. 2007). Humpback whitefish encountered in Alaska have traditionally been classified as *C. pidschian* in interior (Alt 1979) and Arctic habitats (Craig 1984), while in Canada they have been classified as *C. clupeaformis* (Bryan 1973; Craig 1984; Reist and Bond 1988). All humpback whitefish forms are referred to here as *C. clupeaformis*, per McDermid et al. (2007).

Humpback whitefish are rare in the nearshore waters of the Beaufort Sea adjacent to the 1002 Area (Craig 1984; Brown 2008). Similar to the situation with broad whitefish, spawning and overwintering habitats of humpback whitefish are in the lower Sagavanirktok River and farther west and in the Mackenzie River and farther east, so humpback whitefish encountered in or near the 1002 Area are anadromous fish foraging in nearshore and estuarine habitats of the southern Beaufort Sea.

Age at maturity for humpback whitefish range from about age 5 for the earliest maturing populations, such as those in southern Hudson Bay in eastern Canada (Morin et al. 1982) and in the Kuskokwim River (Harper et al. 2007), to age 11 for a much later maturing population in Dease Inlet in western Arctic Alaska (Moulton et al. 1997). River spawning humpback whitefish spawn in flowing water over gravel in late September and early October (Stein et al. 1973; Alt 1979; Brown 2006; Harper et al. 2009). Lake resident populations spawn over rock, gravel, and

sand substrates between mid-October and late December, much later than river spawning populations (Bidgood 1974; Bryan and Kato 1975; Anras et al. 1999). Humpback whitefish in some populations may spawn two or more years in a row (Brown 2006, 2009), while in other populations alternate year spawning may be more common (Lambert and Dodson 1990; Moulton et al. 1997). Humpback whitefish are capable of living for 20 years or more (Moulton et al. 2007; Harper et al. 2007; VanGerwen-Toyne et al. 2008) and the oldest individuals within a population often exceed 30 years (Barnes and Power 1984; Howland et al. 2001b; Brown and Fleener 2001). Humpback whitefish are considered to be a good food fish. They have been exploited in commercial food fisheries in North America more than any other whitefish species (Bodaly 1986; Ebener 1997; Tallman and Friesen 2007) and are routinely harvested in subsistence fisheries in Alaska and northwestern Canada (Corkum and McCart 1981; Georgette and Shiedt 2005).

Least cisco *Coregonus sardinella* are relatively small, pelagic-feeding whitefish found in many Arctic and sub-Arctic waters of Asia and North America (McPhail and Lindsey 1970; Morrow 1980). They have been documented in estuaries, rivers, and lakes from various locations in Alaska and northwest Canada (Alt 1980; Mann and McCart 1981; Reist and Bond 1988; Moulton et al. 1997; Seigle 2003). Because rivers within the 1002 Area do not support spawning or overwintering habitats for least cisco, they spawn and overwinter in aquatic habitats in the Sagavanirktok River and farther west, or in the Mackenzie River and farther east (Craig 1984, 1989a; Reist and Bond 1988). Therefore, least cisco encountered in or adjacent to the 1002 Area are anadromous fish foraging in nearshore and estuarine habitats of the southern Beaufort Sea (Craig 1984; Brown 2008).

Age at maturity for least cisco varies throughout Alaska, with interior and Kuskokwim River fish maturing as early as age 3 (Brown and Fleener 2001; Harper et al. 2007; Brown 2009), age 5 in the Selawik region (Brown 2004), and age 7 in Arctic Alaska (Moulton et al. 1997). Least cisco as old as 25 years or more have been reported (Mann 1974; Moulton et al. 1997). Least cisco are known to undertake extensive spawning migrations from lower drainage or estuarine rearing habitats to spawning habitats that may be several hundred kilometers upstream (Reist and Bond 1988; Brown et al. 2007). Spawning is thought to be either annual (Brown 2004) or less frequent (Mann 1974; Moulton et al. 1997), taking place from late September to early October (Kepler 1973; Mann 1974; Alt 1980). Eggs are broadcast in flowing water over gravel for riverine populations (Alt 1980, 1983; Brown 2009). Isolated populations in lakes are evidently capable of spawning in the absence of flowing water (Doxey 1991), however, actual spawning habitats within lakes have not been identified. Least cisco are harvested in subsistence fisheries as human or dog food but they are generally captured incidentally to other larger whitefish species (Georgette and Shiedt 2005; Moulton and Seavey 2005).

Arctic cisco *Coregonus autumnalis* are relatively small, pelagic-feeding whitefish, with a near circumpolar distribution in Arctic waters (McPhail and Lindsey 1970; Moskalenko 1971). Populations have been documented in several large rivers in northern Europe and Asia, and in the Mackenzie River in northwestern Canada. All evidence indicates that Arctic cisco observed in Alaskan waters originate in the Mackenzie River drainage in Canada (Galloway et al. 1983; Fechhelm et al. 2007; Zimmerman et al. 2013), where several spawning populations have been identified (McLeod and O'Neil 1983; Dillinger et al. 1992). Juveniles disperse throughout the

Beaufort Sea coastal waters of northwest Canada and Alaska for rearing and feeding (Fechhelm and Fissil 1988; Fechhelm and Griffiths 1990; Fechhelm et al. 2007). Overwintering habitats include brackish environments in the Sagavanirktok and Colville River deltas in the west and the Mackenzie and Anderson River deltas in the east (Craig 1984; 1989a; Fechhelm et al. 2007). Arctic cisco encountered in nearshore habitats adjacent to the 1002 Area are either foraging or if mature, are migrating from overwintering habitats in the Colville River delta back to the Mackenzie River to spawn (Craig 1989a; Fechhelm et al. 2007; Brown 2008).

Arctic cisco are fully anadromous and are not known to exist as freshwater residents (Reist and Bond 1988). Age at maturity, based on minimum ages of Arctic cisco sampled from spawning migrations in the Mackenzie River drainage, has been estimated at seven to eight years (Stein et al. 1973; Van Gerwen-Toyne et al. 2008). Arctic cisco are capable of spawning more than once and some may live for as long as 20 years or so (Reist and Bond 1988; Van Gerwen-Toyne et al. 2008). The spawning migration into the Liard River, in the upper Mackenzie River drainage, entails an upstream migration of over 2,000 km (McLeod and O'Neil 1983). During summer, Arctic cisco are one of the most abundant species in nearshore waters of the Beaufort Sea, including areas adjacent to the 1002 Area (Craig 1984; Brown 2008), and one of the primary species taken in the Kaktovik subsistence fishery (Griffiths et al. 1977; Pedersen and Linn 2005).

Round whitefish *Prosopium cylindraceum* are a relatively small, primarily benthic-feeding whitefish common in northern North America and northeastern Asia (McPhail and Lindsey 1970). While anadromous populations of round whitefish exist in certain coastal drainages (Morin et al. 1982), most round whitefish populations are freshwater resident forms, occupying freshwater rivers and lakes (Morrow 1980; Stewart et al. 2007). Round whitefish are present in several drainages and lakes on the North Slope of Alaska (McCart et al. 1972; Alt 1976), but within the 1002 Area they occur only in the Canning River and not farther east (Ward and Craig 1974; Craig 1977c; Smith and Glesne 1983).

Age at maturity for round whitefish ranges from as young as age 3 for early maturing populations, such as those in southeast Canada (Morin et al. 1982), to age 8 or older for later maturing populations such as those in the northeast Asia (Gudkov 1999) and in the upper Chandalar River drainage (Craig and Wells 1975). Spawning for riverine round whitefish takes place in flowing water over gravel in late September and October (Craig and Wells 1975; Zyus'ko et al. 1993). Lake resident populations spawn over a mixed substrate composed of rocks, gravel, and mud in November or December (Normandeau 1969; Bryan and Kato 1975, Haymes and Kolenosky 1984). Round whitefish may spawn every year following maturity, as suggested by Craig and Wells (1975), but most reports suggest that spawning takes place less frequently (Jessop and Power 1973; Zyus'ko et al. 1993; Gudkov 1999). Round whitefish are capable of living for 20 years or more (Craig and Wells 1975; Plumb 2006) and the oldest individuals within a population may exceed 30 years (Gudkov 1999). Round whitefish have been exploited as a food fish for many years in the Laurentian Great Lakes (Mraz 1964; Fleischer 1992). They are occasionally harvested in subsistence fisheries in Alaska but are usually a minor component of the catch (Pedersen and Linn 2005).

Dolly Varden (*Salvelinus malma*) is a coldwater species distributed on the Arctic coast of North America from the Mackenzie River west and south through Alaska to British Columbia and on the western side of the Pacific from the Chukotsk Peninsula of Russia south to Japan and Korea (Scott and Crossman 1973; Reist et al. 1997; DeCicco 1997). Previous to 1997, Dolly Varden in northern Alaska were often referred to as Arctic char (*Salvelinus alpinus*), although for many decades there has been an understanding that there were morphological differences between char to the east of the Mackenzie River and those to the west (McCart 1980). Reist et al. (1997) conducted detailed morphology and genetics analyses and formally established anadromous char in northern Alaska and northwest Canada as Dolly Varden.

Dolly Varden are widely distributed within the northern part of the Arctic NWR and several rivers flowing through the 1002 Area support spawning populations including the Canning (Craig 1977c), Hulahula (Daum et al. 1984; Brown et al. 2014), and Aichilik (Craig and McCart 1974; West and Wiswar 1985) rivers. In addition, several isolated resident populations have been documented in springs and lakes in the Canning (McCart and Craig 1973; Craig 1977c), Sadlerochit (Craig 1977b; Wiswar 1994), and Jago (Daum et al. 1984) River drainages. It should be noted that it isn't clear at this point whether the lake resident char in the Jago River valley (Daum et al. 1984) are Dolly Varden or Arctic char.

Resident and anadromous forms of Dolly Varden exhibit a number of distinct life history characteristics (Craig and McCart 1974; McCart 1980). Resident fish rarely achieve seven years of age and typically do not exceed 250 mm in length (Craig 1977b; Craig 1978; Armstrong and Morrow 1980). Resident fish primarily feed on dipteran larvae and other macroinvertebrates, achieve sexual maturity between the ages of two and four, and with few exceptions, utilize spring habitat exclusively for all life history stages (Craig 1977b; McCart 1980). Alternatively, anadromous fish may live to 10 years of age or more and grow to over 800 mm in length (Armstrong and Morrow 1980; Craig and Haldorson 1981; Underwood et al. 1996). Sexual maturity may be attained as early as 4 years for certain precocious individuals, although the majority of anadromous fish don't mature until 6 or 8 years at lengths of 400 mm or greater (McCart 1980; Underwood et al. 1996). First migration to sea occurs between the ages of 2 and 5 years, with the majority of individuals migrating at 3 to 4 years (Yoshihara 1973; McCart 1980; Underwood et al. 1996). In late spring or early summer, Dolly Varden migrate to brackish, nearshore coastal areas of the Beaufort Sea from overwintering habitats in deep pools and spring-fed areas in coastal rivers (Craig 1989a; Fechhelm et al. 1997; Jarvela and Thorsteinson 1997). While at sea, individuals move extensively along the Arctic coast within mixed-stock aggregates feeding heavily upon mysid shrimp and amphipods with some incidence of piscivory (Craig 1984, 1989a; Krueger et al. 1999). Additionally, recent satellite telemetry data indicate that at least some Dolly Varden migrate as much as 60 km or more offshore, a migratory phenomenon that was previously unknown (Courtney et al. 2018). Anadromous Dolly Varden return to freshwater in late summer or early fall to spawn and overwinter (Craig 1984; Craig 1989a). Catch data indicate that the majority of returning spawners are female, suggesting different rates of mortality among the sexes. However, because virtually all individuals of the anadromous populations that remain resident are male (Furniss 1975; Craig 1978; McCart 1980), and those residual males can be very numerous on spawning grounds, it is thought that they account for the proportional differences between males and females observed returning from the sea. Spawning is thought to occur most often in non-consecutive years with mature females

building redds within spring-fed areas of tributary streams and rivers where males compete for access (Furniss 1975; McCart 1980). Genetic structure within drainage systems indicates that spawning fish display a high level of fidelity to natal drainages (Everett et al 1997; Krueger et al. 1999; Crane et al. 2005). Some individuals are known to overwinter in non-natal drainages during nonspawning years (McCart 1980; Brown et al. 2014). Fry emerge from nests under ice cover in May and June and are believed to remain in close proximity to spawning beds throughout the first year of life (McCart 1980).

Anadromous Dolly Varden are the primary species caught in subsistence fisheries by residents of Kaktovik, in a winter fishery at Fish Hole 2 on the Hulahula River and in coastal areas during the summer (Craig 1989b; Pederson and Linn 2005). There is also evidence of recreational use and harvest on some of the more popular rivers that flow through the 1002 Area (Arvey 1991; Jennings et al. 2010)

Arctic char (*Salvelinus alpinus*) inhabit freshwater and marine habitats and exhibit a circumpolar distribution within the Holarctic (Johnson 1980; Reist et al. 1997). While both anadromous and freshwater-resident forms are present within Alaska, only lake-resident populations exist within the Arctic NWR (Reist et al. 1997). Within North Slope drainages, populations have been documented in a few lakes within the upper Canning and Sagavanirktok River drainages (McCart et al. 1972; Craig 1977c) and in Peters and Schrader lakes in the upper Sadlerochit River drainage (Ward and Craig 1974; Craig 1977c). It is also possible that isolated lake-resident char in the Jago River drainage are Arctic char but meristic data necessary to make that determination is not available (Daum et al. 1984). At this time, Arctic char have not been documented in waterbodies within the 1002 Area.

Arctic char body size and growth varies dramatically among areas, but in general, lake-resident Arctic char are smaller and grow at slower rates relative to anadromous forms (Craig 1977c). For example, lake-resident Arctic char in Big Lake, located in the headwaters of the Canning River, were found not to exceed 190 mm in length, while populations in adjacent lakes reached sizes upwards of 400 mm (Craig 1977c). Sexual maturity is attained between the ages of 3 and 8 with maximum ages greater than 10 years (Craig 1977c). Spawning is thought to occur during fall in deeper portions of lacustrine habitats to avoid ice scouring (Armstrong and Morrow 1980). Individuals feed non-selectively on insect larvae, amphipods, planktors, and fish where available (Craig 1977c; Armstrong and Morrow 1980). No data regarding abundance or harvest are currently available.

Lake trout (*Salvelinus namaycush*) inhabit deep, coldwater lakes and are widely distributed throughout northern North America from the Alaskan peninsula east across Canada to Nova Scotia and south to northern New York (Scott and Crossman 1973). Within the Refuge, lake trout are present in some coastal and headwater lakes where suitable overwintering habitat exists (Scott and Crossman 1973). On the North Slope, lake trout have been documented in Elusive Lake in the Sagavanirktok River drainage, two unnamed coastal lakes in the Canning River drainage, and Okpilak, Wahoo, Peters, and Schrader lakes (Ward and Craig 1974; Daum et al. 1984; Bendock and Burr 1985; West and Fruge 1989). At this time, Lake trout have not been documented in waterbodies within the 1002 Area.

Lake trout are long-lived (40+ years) and can reach sizes upwards of 1,000 mm fork length (Furniss 1974; Craig and Wells 1975; Morrow 1980). Individuals feed on invertebrates early in life, eventually shifting to a piscivorous diet as gape expands with increasing body size. Forage likely consists of any co-occurring fish species, with documented consumption of Arctic char, ninespine stickleback, slimy sculpin, Arctic grayling, and whitefish (*Coregonus* spp.) in Alaska (Burr 1990; McDonald and Hershey 2006; Swanson et al. 2010). Lake trout become sexually mature between the ages of 5 and 13 with the majority of individuals maturing at 7 or 8 years (Craig and Wells 1975; Morrow 1980). In general, lake trout spawn in the fall over large boulder or rubble substrate at depths less than 13 m (Scott and Crossman 1973). Time of and length at emergence varies depending on habitat conditions with eggs typically requiring a 4 to 5 month incubation period (Martin 1957).

The Schrader Lake population of lake trout was estimated to contain roughly 7,000 individuals in 1995, with the majority of fish ranging between 390 and 500 mm in length (Lubinski et al. 1999). Lake trout from Peter and Schrader lakes are harvested in subsistence fisheries by residents of Kaktovik (Craig 1989b; Pederson and Linn 2005). Elusive Lake, located in the Ribdon River drainage supports a small lake trout sport fishery, however no specific sport harvest data could be found for Refuge waters (Bendock and Burr 1985; Jennings et al. 2010).

Chum salmon (*Oncorhynchus keta*) are distributed on the western coast of North America from southern California to the Arctic and in Asia from Siberia south to Japan (Scott and Crossman 1973). Chum salmon are semelparous and anadromous, with adults typically ranging between 550 and 650 mm in length (Horne-Brine et al. 2009). Fry emerge from gravel nests in early spring and shortly thereafter begin to disperse to the marine environment. At sea, juveniles prey upon various copepods and amphipods until growth permits the consumption of fish (Salo 1991). Individuals return to freshwater to spawn in natal tributaries beginning in summer and fall between the ages of two and six, with the majority of fish returning as four and five year olds (Gilk et al. 2009; Horne-Brine 2009). On the spawning grounds, females construct gravel nests where eggs are deposited and subsequently covered with gravel (Morrow 1980).

Within North Slope waters of the Arctic NWR, chum salmon have been captured in low numbers in the Sadlerochit, Sagavanirktok, and Canning rivers as well as nearshore coastal areas (Smith and Glesne 1983; Craig and Haldorson 1986; Brown 2008). Some believe that self-sustaining chum salmon populations may exist in the Mackenzie River drainage while others consider all encountered in the Beaufort Sea to be strays originating from more southerly drainages (Craig and Haldorson 1986; Irvine et al. 2009b). Residents of Kaktovik infrequently harvest chum salmon in subsistence fisheries in nearshore areas surrounding Barter Island in the southern Beaufort Sea (Pedersen and Linn 2005).

Chinook salmon (*Oncorhynchus tshawytscha*) are distributed along the west coast of North America from southern California to Point Hope, Alaska and in Asia from Siberia south to Japan (Scott and Crossman 1973). Within the northern part of the Arctic NWR, Chinook salmon are rarely encountered in nearshore environments and have not been captured in any of the rivers, despite occasional catches in the Colville River to the west and Mackenzie River to the east (Craig and Haldorson 1986; Stephenson 2006; Irvine et al. 2009a). Chinook salmon are

anadromous, semelparous, and the largest of the Pacific salmon species. Adults commonly reach lengths of 430 to 860 mm but may grow to upwards of 1000 mm on occasion (Horne-Brine et al. 2009). Fry emerge in spring and usually spend the first year of life in freshwater habitats feeding on aquatic and terrestrial invertebrates (Wipfli 2009). Smolts migrate to sea in spring where growth rates subsequently increase as individuals shift to a primarily piscivorous diet (Bradford et al. 2009). In the ocean, the majority of Chinook salmon occupy habitats in the southern Bering Sea where they spend between one and five years before returning to natal freshwater streams to spawn in mid-July to late August (Healey 1991). On the spawning grounds, females construct gravel nests in flowing water where eggs are deposited and covered with substrate.

Arctic grayling (*Thymallus arcticus*) reside in lakes and rivers of northern North America from Hudson Bay to the western shores of Alaska and in Asia from Siberia to North Korea (Scott and Crossman 1973). In Beaufort Sea drainages of the Arctic NWR, including those flowing across the 1002 Area, Arctic grayling are widespread and abundant (Garner and Reynolds 1986; Craig and Wells 1975). Sexual maturity is attained between the ages of four and eight with individuals typically reaching 300 to 350 mm in length and between 450 and 750 grams in weight (McCart et al. 1972; Craig and Poulin 1975; Morrow 1980). Spawning occurs annually shortly after break up in early spring in small river and lake tributaries over areas of sandy gravel (Bishop 1971). When stream habitat is not available, spawning may also occur in larger substrates in rivers and lakes (Scott and Crossman 1973). Males are territorial on the spawning grounds however no nest is constructed (Kratt and Smith 2006). The incubation period is relatively short and juvenile fish emerge from the substrate roughly 9 to 21 days following spawning, depending on water temperature (Morrow 1980; Kratt and Smith. 1977). Adults feed on aquatic and terrestrial invertebrates and may undertake extensive inter- and intra-drainage movements between overwintering sites (deep pools, lakes, spring-fed areas) and summer feeding habitats following reproduction (Craig and Poulin 1975; West et al. 1992). Arctic grayling are, at least for short periods, tolerant of saline conditions, as individuals are sometimes captured in estuarine waters during inter-drainage movements in coastal systems (West et al. 1992). Additional biological information regarding Arctic grayling inhabiting North Slope rivers and lakes within the Arctic NWR are present in a number of publications (Furniss 1975; Garner and Reynolds 1986; Deschemeier et al. 1986; Wiswar 1991, 1992, 1994; West et al. 1992). Recreational harvest is likely to occur throughout the Refuge, although, no specific data are available (Jennings et al. 2010).

Burbot (*Lota lota*) inhabit deep areas of rivers and lakes of the circumpolar north extending south into some temperate areas of Europe, Asia, and North America (Morrow 1980). Within North Slope waters of the Arctic NWR, burbot have been documented in lakes and main-stem areas of the Canning River, including the segment along the western boundary of the 1002 Area (Ward and Craig 1974; Craig 1977c; Smith and Glesne 1983) and in the Sagavanirktok River but not in any other rivers or lakes within the 1002 Area (Bendock 1980; Bendock and Burr 1985). Burbot are rarely observed in nearshore environments (Craig 1984).

Burbot typically reach lengths of 400 to 550 mm and weigh between 0.5 and 1 kg, however, individuals greater that 1,500 mm and weighting over 30 kg have been reported (Chen 1969; Evenson 1990). Most individuals are sexually mature by the age of seven (earlier in southern latitudes) and spawn under the cover of ice between the months of November and

February (Chen 1969). Spawning may not be an annual event and generally takes place over gravel and sand substrate in relatively shallow areas of rivers and lakes (Chen 1969; Breeser et al. 1988). Eggs and sperm are released simultaneously by a mating pair with fertilized eggs settling into spaces in the substrate and developing over the next one to two months without parental care. Juvenile burbot feed on insect larvae and other invertebrates until roughly the third or fourth year after which they feed primarily on fish (Chen 1969). Seasonal movements ranging from a few kilometers to over 250 kilometers have been reported within riverine populations most likely associated with the connection of spawning and foraging habitats (Percy 1975; Breeser et al. 1988; Evenson 1993).

Ninespine stickleback (*Pungitius pungitius*) are distributed in North America from Cook Inlet, Alaska, north to the Arctic Ocean and southeast through Canada terminating on the Atlantic Coast of New England (Scott and Crossman 1973; Morrow 1980). Within North Slope waters of the Arctic NWR, ninespine stickleback are present in the lower reaches of most of the major drainages including those that flow through the 1002 Area (Ward and Craig 1974; Craig 1977a; Wilson et al. 1977; Bendock and Burr 1985). Furthermore, ninespine stickleback are commonly found in coastal brackish lagoons (Griffiths et al. 1977; West and Wiswar 1985; Wiswar et al. 1995; Brown 2008) and coastal lakes where they are often the only species present (West and Fruge 1989; Trawicki et al 1991; Wiswar 1994).

Ninespine stickleback are tolerant of salinities < 20 ppt and may move between fresh and saltwater throughout the year as access and conditions permit (Wooton 1984). Individuals attain sexual maturity by the age of two, seldom live beyond the age of five, and typically reach 65 mm in length with some as large as 90 mm (Scott and Crossman 1973; Heins et al. 2003). Spawning occurs in freshwater between the months of May and July in shallow areas containing aquatic vegetation (Wooton 1984). Males construct nests from algae and small debris where females deposit eggs. After fertilization, males protect nesting areas from predators and fan oxygenated water over the clutch of eggs. Young emerge roughly a week to a month later at which time males continue to provide care by preventing them from straying from nursery areas. Little is known regarding seasonal movements, however, spawning individuals likely move from shallow (littoral, tributary, or slough habitat) to deep (river deltas, coastal areas, lake bottoms) areas in fall (Wooton 1984). Ninespine stickleback prey on aquatic insects and small crustaceans and are an important prey item of predatory fish and birds (Palmer 1962; Morrow 1980). Additional biological data on ninespine stickleback are available in numerous publications (Yoshihara 1972; Ward and Craig 1974; Craig 1977a; Griffiths et al. 1977; Wilson et al. 1977; Bendock and Burr 1985; West and Wiswar 1985; West and Fruge 1989; Trawicki et al 1991; Wiswar et al. 1995; Jarvela and Thorsteinson 1999; Brown 2008). While they are commonly found in most North Slope coastal habitats of the Refuge, catch rates vary dramatically among areas and years.

Arctic cod (*Boreogadus saida*) is a marine species distributed throughout the entire northern polar basin, around Greenland and Iceland**,** into Hudson Bay, and in the North Bering Sea (Cohen et al. 1990). Arctic cod are commonly encountered and sometimes abundant in nearshore coastal areas adjacent to the Arctic NWR in the southern Beaufort Sea (Craig et al. 1982; Brown 2008).

Arctic cod prefer cold (0-6°C), saline (20-30 ppt) habitats but are at least temporarily tolerant of fluctuating temperatures, salinities, and turbidities as they are found in both in-and off-shore marine areas, estuaries, and occasionally in in the lower reaches of coastal rivers (Lowry and Frost 1981; Craig et al. 1982; Cohen et al. 1990). Adults typically range between 60 and 170 mm in length with some individuals reaching 250 mm (Craig et al.1982). Sexual maturity is attained between the ages of two and three with maximum ages of six to seven years (Lear 1979; Craig et al.1982). During late summer and fall, Arctic cod may aggregate into large schools and move into nearshore coastal areas that are transitioning from estuarine to marine conditions (Craig et al 1982; Hop et al. 1997). Seasonal movements and schooling behavior may be associated with spawning, foraging, predator avoidance, or habitat availability as Arctic cod are often found associated with the edges of pack ice (Welch et al.1993; Hop et al. 1997). Spawning occurs under ice between the months of November and March, presumably close to shore (Lowry and Frost 1981; Craig et al. 1982). Arctic cod prey on amphipods, copepods, and mysid shrimp and are an important prey item for many species of marine mammals, birds, and fish (Palmer 1962; Craig et al. 1982; Craig et al. 1984; Frost and Lowry 1984).

Arctic cod may be the most abundant and widely distributed fish species in the Beaufort Sea (Lowry and Frost 1981; Craig et al. 1982; Craig 1984). Catch data suggest Arctic cod are more abundant in coastal areas west of the Arctic NWR with one estimate, during the summer of 1978 in Simpson lagoon, numbering in the millions (Craig et al. 1982; Jarvela and Thorsteinson 1999). Within waters adjacent to the Arctic NWR, catch rates of Arctic cod are variable within and among years and areas but tend to increase during late summer and fall (Griffiths et al. 1977; Fruge et al. 1989; West and Fruge 1989; Underwood et al. 1995; Wiswar et al. 1995; Jarvela and Thorsteinson 1999; Brown 2008). There is some evidence that Arctic cod are harvested in subsistence fisheries in Kaktovik and Jago lagoons by residents of Kaktovik (Griffiths et al. 1977).

Saffron cod (*Eleginus gracilis*) is a marine species distributed throughout the North Pacific from the Yellow Sea in Asia to Southeast Alaska and north in the Arctic Ocean from eastern Siberia to northwestern Canada (Morrow 1980; Cohen et al. 1990). Saffron cod are widely distributed in the Beaufort Sea including coastal areas adjacent to the Arctic NWR (Wiswar and West 1987; Fruge et al. 1989; Wiswar et al. 1995; Brown 2008).

Saffron cod inhabit both in- and off-shore marine and estuarine areas and are occasionally found in the lower reaches of coastal rivers (Morrow 1980). Average adult lengths range between 250 and 350 mm, with some individuals reaching up to 500 mm (Craig and Haldorson 1981). Sexual maturity is attained between the ages of two and three, with maximum ages reported between 10 and 12 years old (Cohen et al. 1990). Fish tend to move inshore in fall and winter to spawn, then move offshore in spring and summer to feed in deeper habitats (Morrow 1980). Forage consists of mysid shrimp, amphipods, and decapods, with larger individuals ingesting fish (Ellis 1962; Craig and Haldorson 1981)

Biological data pertaining to saffron cod are largely limited to catch data and are available for nearshore areas of the Beaufort Sea adjacent to the Arctic NWR (Griffiths 1984, Wiswar and West 1987; Fruge et al. 1989; Wiswar et al. 1995; Brown 2008) and in other

locations (Bendock 1977**;** Craig et al. 1985**;** Griffiths et al. 1998; Fechelm et al. 2006). Catch rates vary substantially among years and areas.

Fourhorn sculpin (*Myoxocephalus quadricornis*) is a marine species distributed throughout the circumpolar north from the Baltic Sea, east across northern Siberia to the Arctic coast of Canada and south to Norton Sound, Alaska (Andriyashev 1954; Morrow 1980). Fourhorn sculpin are often abundant in nearshore coastal areas of the Beaufort Sea adjacent to the Arctic NWR (Griffiths et al. 1977; West and Wiswar 1985; Wiswar and West 1987; Underwood et al. 1995; Wiswar et al. 1995; Jarvela and Thorsteinson 1999; Brown 2008).

Fourhorn sculpin rarely descend below 15-20 meters in depth and inhabit cold nearshore marine and estuarine coastal areas year-round, occasionally moving into the lower reaches of coastal streams and rivers (Griffiths et al. 1977; Morrow 1980). Adults typically reach 280 mm in length but may grow to 365 mm and live to 14 years of age (Andriyashev 1954; Percy et al. 1974; Griffiths et al. 1975). Sexual maturity is attained between the ages of three and nine with the majority of fish mature by the age of six (Griffiths et al. 1975; Griffiths et al. 1977). Spawning is thought to occur in winter, although evidence of summer spawning also exists (Goldberg et al. 1987), with males excavating shallow depressions in soft substrate where females deposit eggs (Westin 1969). After fertilization, males remain in close proximity to the nest site, cleaning and fanning oxygenated water over the eggs. Young emerge two to three months later, depending on water temperature, and move into shallow waters close to shore (Westin 1970). Seasonal on- and off-shore movements by adults may be common with individuals feeding on invertebrates such as mysids, amphipod, isopods, and occasionally small fish (Griffiths et al. 1975; Griffiths et al. 1977).

Biological data pertaining to fourhorn sculpin are largely limited to catch data and are available for nearshore areas of the Beaufort Sea adjacent to the Arctic NWR (Griffiths et al. 1977; West and Wiswar 1985; Wiswar and West 1987; Underwood et al. 1995; Wiswar et al. 1995; Jarvela and Thorsteinson 1999; Brown 2008) and in other locations (Percy et al. 1974; Griffiths et al 1975; Craig and Haldorson 1981; Jarvela and Thorsteinson 1999). While catches vary among years and areas, fourhorn sculpin are typically one of the most abundant marine species in nearshore areas of the Arctic NWR.

Arctic flounder (*Pleuronectes glacialis*) is a marine species distributed from Queen Maude Gulf in Arctic Canada west along the coast of North America to Siberia and south to Bristol Bay, Alaska (Andriyashev 1954; Morrow 1980). Fishbase (Froese and Pauly 2017), a world-wide, web-based, fish taxonomy guide, classifies Arctic flounder as *Liopsetta glacialis* while the American Fisheries Society classifies the species as *Pleuronectes glacialis* (Page et al. 2013). We use the American Fisheries Society classification here. Arctic flounder are found throughout nearshore coastal areas of the Beaufort Sea adjacent to the Arctic NWR (Griffiths et al. 1977; Wiswar 1986; Jarvela and Thorsteinson 1999; Brown 2008).

Arctic flounder typically remain close to shore, inhabiting shallow brackish water habitats and river deltas, occasionally entering rivers and delta lakes (Craig 1977c; Wilson et al. 1977). Adults range between 150 and 250 mm in length, attain sexual maturity between the fourth and fifth years, and generally live to between 9 and 12 years of age, however, specimens

as old as 19 have been reported (Andriyashev 1954; Griffiths et al. 1975; Griffiths et al 1977; Bendock 1979; Morrow 1980). Spawning is thought to occur in coastal areas between January and March but possibly as late as May in some areas (Andriyashev 1954; Morrow 1980). Young emerge roughly 40 days after fertilization depending on water temperature (Aronovich et al. 2003). Seasonal on- and off-shore movements are thought to occur with forage consisting mainly of amphipods, mollusks, crustaceans, and small fish (Griffiths et al. 1975; Morrow 1980; Wiswar 1986).

Relative to Arctic cod and fourhorn sculpin, Arctic flounder are less frequently captured, but still common in nearshore areas of the Beaufort Sea coast (Percy et al. 1974; Griffiths et al 1975; Craig and Haldorson 1981; Jarvela and Thorsteinson 1999; Fechelm et al. 2006), including areas adjacent to the Arctic NWR (Griffiths et al. 1977; Wiswar 1986; Underwood et al. 1995; Jarvela and Thorsteinson 1999; Brown 2008). In addition, Arctic flounder are infrequently captured in subsistence fisheries by the residents of Kaktovik in waters surrounding Barter Island (Pedersen and Linn 2005).

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Subject Area: Fishes

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Individuals contacted: Vanessa von Biela, USGS, <vvonbiela@usgs.gov>, (907) 786-7073; Mathew Whitman, U.S. Bureau of Land Management, <MWhitman@blm.gov>, (907) 474-2249

What do we need to know about fishes and why:

Water is essential fish habitat. Water is also a critical component in virtually all stages of the industrial process of hydrocarbon development. Potential sources of water for industrial use along Alaska's North Slope include rivers, lakes, snow, and ice; perhaps even desalinated marine sources. Fish depend on the aquatic environments of nearly all rivers, many lakes, and the near-shore marine areas in or adjacent to the 1002 Area. Surplus water, water that is present in rivers and lakes and in the form of snow and ice, that is not required to sustain fish populations, would conceivably be available for industrial use. If our goal is minimizing the impact of industrial development on fishes that live in or migrate through the 1002 Area we must identify water that is required to sustain them and preserve that water for fish use.

In addition to direct industrial use of water, seismic activity during the exploratory phase of hydrocarbon development has the potential to impact fishes as well. In recent years winter seismic surveys most commonly use a truck-based technology called Vibroseis to generate the acoustical energy pulses necessary to locate subsurface geological formations that might contain oil or gas. Vibroseis is much less harmful to fishes than explosive charges that were commonly used in the past. These downward directed pulses of acoustic energy create pressure waves into the ground or through ice into lakes and rivers below. They are known to influence the behavior of fish in the vicinity of the energy source, although experimental data suggest it does not cause the physical damage typical of explosives.

What information is currently available to address the information needs for fishes:

The eastern North Slope in Alaska is endowed with limited freshwater options for fish. As a result, there are only a few species that occupy the freshwater habitats that are available. Lake density is very low east of the Canning River drainage but increases progressively to the west. Several mountain streams cross the coastal plain between the Canning River and the Canadian border. These streams flow during summer with snowmelt, rainfall, perennial springs, and for some streams, melting glaciers, however, only the perennial springs provide flow during winter reducing habitable environments for fishes to about 5% of what is available during summer.

The nearshore environment in the southern Beaufort Sea, adjacent to the coastal plain of the eastern North Slope in Alaska, is a mix of open coast and lagoons bounded by barrier islands. In summer, water along the coast becomes brackish and relatively warm because of flow from the Mackenzie River and other rivers along the eastern Arctic coastline. The lagoons are relatively shallow, the amplitude of the tides is very small (≤30 cm), barrier islands restrict flow to some extent, and the environment becomes much less salty and much warmer than sea water outside the barrier islands. The lagoons are very productive foraging environments for marine and anadromous species during summer. In winter, in part because of reduced flow between lagoons and the sea, and in part because of ion exclusion during ice formation, lagoons become hypersaline environments that get even colder than normal sea water under ice. As winter approaches and the lagoons begin freezing up, anadromous fishes return to freshwater environments and marine fishes retreat to adjacent marine habitats.

Freshwater species present in the eastern North Slope of Alaska include lake trout *Salvelinus namaycush*, Arctic char *S. alpinus*, Dolly Varden *S. malma*, Arctic grayling *Thymallus arcticus*, round whitefish *Prosopium cylindraceum*, burbot *Lota lota*, ninespine stickleback *Pungitius pungitius*, and slimy sculpin *Cottus cognatus*. Slimy sculpin are known to occur only in drainages west of the Canning River. Round whitefish and burbot are present in the Canning River and large drainages farther west but not east of the Canning River. Lake trout and Arctic char are found only in certain lakes. Dolly Varden is present in three life history forms: anadromous populations in which most members rear in freshwater rivers for 2–4 years then begin migrating to sea to feed each summer; residual dwarf males of the anadromous populations that choose to stay in freshwater rivers rather than migrate to sea; and dwarf resident populations that exist in perennial springs and isolated lakes. Arctic grayling occur in some lakes and also in rivers with perennial springs that are used for overwintering habitat. Ninespine stickleback occur as both freshwater residents and as anadromous forms. They are common in lakes within the coastal plain and the lower reaches of many rivers throughout the eastern North Slope.

Anadromous species known to occur in or adjacent to the eastern North Slope of Alaska include Dolly Varden, ninespine stickleback, Arctic cisco *Coregonus autumnalis*, broad whitefish *C. nasus*, humpback whitefish *C. clupeaformis*, least cisco *C. sardinella*, chum salmon *Oncorhynchus keta*, pink salmon *O. gorbuscha*, Chinook salmon *O. tshawytscha*, and rainbow smelt *Osmerus mordax*. Dolly Varden and ninespine stickleback are the only anadromous species in this group that maintain populations within the rivers of the eastern North Slope. Dolly Varden are known to migrate long distances along the coast during their summer feeding forays, east to the Mackenzie River and west to the Colville River or beyond, and some individuals migrate into offshore waters as well. Ninespine

stickleback appear to be much more localized in nearshore environments. Arctic cisco have natal origins in the Mackenzie River to the east but disperse as juveniles to coastal habitats farther west including the Colville River delta, where many overwinter in brackish environments. Rearing Arctic cisco make annual feeding migrations along shore during summer and eventually return to the Mackenzie River to spawn. Broad whitefish, humpback whitefish, and least cisco that are encountered in nearshore environments in the eastern Arctic have natal origins in either the Mackenzie River to the east or the Sagavanirktok or Colville rivers to the west. Salmon species that occur in the eastern Arctic are thought to be strays from southern Chukchi or northern Bering Sea populations, although some believe that self-sustaining chum salmon populations may exist in the Mackenzie River drainage somewhere. Rainbow smelt are known to spawn in the Mackenzie and Colville rivers as well as in the Kuk River drainage farther west. Dolly Varden and Arctic cisco are the primary food fishes for people in north east Alaska.

There are about 12 species of marine fishes that are commonly encountered in nearshore brackish environments, only four of which are relatively abundant during the summer season. These are fourhorn sculpin *Myoxocephalus quadricornis*, Arctic flounder *Pleuronectes glacialis*, saffron cod *Eleginus gracilis*, and Arctic cod *Boreogadus saida*. While anadromous species tend to migrate along shore in the southern Beaufort Sea, marine species are thought to follow a very different pattern; moving towards shore and into shallow water during summer and away from shore and into deeper water during winter. It is not uncommon to find these four common marine species in brackish environments during summer, or even in the very lower reaches of the rivers in the area.

What are the key information gaps:

We currently have a good understanding of fish species present in or near the 1002 Area, as well as the types of aquatic habitats they use. We have some information on species presence in specific lakes, streams, and near-shore habitats. We don't have this information for all aquatic habitats that might be considered for exploratory seismic surveys or industrial water use. This information will be important prior to permitting for these activities.

We do not have a good understanding of the consequences of harvesting aufeis from perennial springs on flow levels downstream the next summer. Will it be adequate to support fish migration or not? This information will be important prior to permitting the use of aufeis.

What studies or surveys need to be conducted to fill those information gaps:

From:	Crane, Drew
To:	Greta Burkart; Janet Jorgenson; Paul Leonard; Edward Decleva; Peter Butteri; Roy Churchwell; Stephen Arthur; Hollis Twitchell; Christopher Latty; Richard Lanctot; Jim Johnson; Steve Lewis; Michael Swaim; Julian Fischer; Eva Patton; Carl Johnson; Robbin Lavine; Susan LaKomski; Jennifer Reed; Roger Kaye; John Martin
Cc:	Eric Taylor; John Trawicki; Wendy Loya; Damberg, Doug; Steve Berendzen; Fox, Joanna
Subject:	Save the Date - May 3 - 1002 Scoping Mtg w/BLM
Date:	Monday, April 23, 2018 1:11:21 PM

Hi All,

With the announcement of the scoping notice for the 1002 EIS, BLM has also awarded a contract to a consultant to help develop the document. As a part of the contract, an internal scoping meeting with BLM and FWS will be held on May 3. A location and time have not been identified yet, but an invitation will be sent out once they are. As members of the IDT team from FWS that we put forward, you may be requested to attend this meeting. Wendy or I will forward any additional information that we receive on this topic.

Thank you,

Drew Crane
Regional Endangered Species Coordinator
Alaska Region
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503
907-786-3323

From:	Fox, Joanna
To:	Roy Churchwell
Subject:	Fwd: Attachments to Calendar Invite on 5/3
Date:	Monday, April 30, 2018 11:59:36 AM
Attachments:	SO3355.pdf FINAL_CoastalEIS_IntScopAgnda_20180503.pdf Section 20001.pdf

Hi Roy,

Here is the agenda for the Thursday meeting; it includes the conference call information. I would think that perhaps the welcome and program overview, and the 11-12:15 session on natural resources might be of most interest/value to you.

Thanks,
Joanna

____

Joanna L. Fox
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"Do what you can, with what you have, where you are." -- Theodore Roosevelt

---------- Forwarded message ----------
From: **Hayes, Miriam (Nicole)** <mnhayes@blm.gov>
Date: Fri, Apr 27, 2018 at 12:35 PM
Subject: Attachments to Calendar Invite on 5/3
To: John Trawicki <john_trawicki@fws.gov>, Erin Julianus <ejulianus@blm.gov>, Christopher Putnam <christopher_putnam@fws.gov>, Robert Brumbaugh <rbrumbau@blm.gov>, "Kenneth (Alan) Peck" <kpeck@blm.gov>, Scott Guyer <sguyer@blm.gov>, Donna Wixon <dwixon@blm.gov>, "Whitman, Matt" <mwhitman@blm.gov>, Joanna Fox <joanna_fox@fws.gov>, "Goodwin, Randy" <rgoodwin@blm.gov>, Marlo Draper <mdraper@blm.gov>, Joseph Galluzzi <jgalluzz@blm.gov>, "Robert (Bob) King" <r2king@blm.gov>, Drew Crane <drew_crane@fws.gov>, Thomas St Clair <tstclair@blm.gov>, Michael McCrum <mmccrum@blm.gov>, Chad Ricklefs <chad.ricklefs@empsi.com>, Catherine Hillis <chillis@blm.gov>, Wendy Loya <wendy_loya@fws.gov>, Joseph Keeney <jkeeney@blm.gov>, "Hamfler, Cindy" <chamfler@blm.gov>, Steve Berendzen <steve_berendzen@fws.gov>, Eric Taylor <eric_taylor@fws.gov>, "Allen, Stewart" <sdallen@blm.gov>, Timothy Vosburgh <tvosburgh@blm.gov>, Richard Kemnitz <rkemnitz@blm.gov>, Krystal Debenham <kdebenham@blm.gov>, Serena Sweet <ssweet@blm.gov>, Lesli Ellis-Wouters <lellis@blm.gov>, Tracy Fischbach <tracy_fischbach@fws.gov>, Faith Martineau <faith.martineau@caelusenergy.com>, Jessie Chmielowski <jchmielowski@blm.gov>, Thomas Bickauskas <tbickaus@blm.gov>, "Nichelle (Shelly) Jones" <njones@blm.gov>, Casey Burns <ctburns@blm.gov>, Sarah

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Some of you may not be able to access the attachments in the calendar invite so I am sending them out separately via email.

I apologize in advance for any duplication.

Nicole

Nicole Hayes
Project Coordinator
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THE SECRETARY OF THE INTERIOR
WASHINGTON

ORDER NO. 3355

Subject: Streamlining National Environmental Policy Act Reviews and Implementation of Executive Order 13807, "Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects"

Sec. 1 **Purpose**. This Order is intended to: 1) immediately implement certain improvements to National Environmental Policy Act (NEPA) reviews conducted by the Department of the Interior (Department); 2) begin assessment of additional such opportunities; and 3) begin implementation of Executive Order 13807 of August 15, 2017, "Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects" (E.O. 13807).

Sec. 2 **Authorities**. This Order is issued under the authority of section 2 of Reorganization Plan No. 3 of 1950 (64 Stat. 1262), as amended. Other statutory authorities for this Order include, but are not limited to, NEPA, 42 U.S.C. 4321-4347.

Sec. 3 **Background**. The Department has broad responsibilities to manage Federal lands and resources for the public's benefit. The NEPA applies to the execution of many of the Department's responsibilities with the goal of ensuring that information regarding environmental impacts is available to decisionmakers and the public before decisions are made. The NEPA accomplishes this goal by requiring Federal agencies to prepare an Environmental Impact Statement (EIS) for major Federal actions significantly affecting the quality of the human environment.

Both the Department and the Council on Environmental Quality (CEQ) have issued regulations to implement NEPA. Because the purpose of NEPA's requirements is not the generation of paperwork, but the adoption of sound decisions based on an informed understanding of environmental consequences, the regulations encourage agencies to: 1) focus on issues that truly matter rather than amassing unnecessary detail; 2) reduce paperwork, including by setting appropriate page limits; 3) discuss briefly issues that are not significant; and 4) prepare analytic (rather than encyclopedic) documents, among other measures.

In recognition of the impediments to efficient development of public and private projects that can be created by needlessly complex NEPA analysis, I am issuing this Order to enhance and modernize the Department's NEPA processes, with immediate focus on bringing even greater discipline to the documentation of the Department's analyses and identifying opportunities to further increase efficiencies.

This NEPA-streamlining effort dovetails with E.O. 13807. Among other requirements, E.O. 13807 requires CEQ to take actions to enhance and modernize the Federal environmental review process and to form an inter-agency working group to identify agency-specific

impediments to efficient and effective reviews for covered infrastructure projects. This Order begins implementation of E.O. 13807 in the context of the Department's overall effort to streamline the NEPA process.

Sec. 4 **Directives**.

a. Setting Page and Timing Limitations for Environmental Impact Statements.

(1) To implement the longstanding directives in 43 C.F.R. 46.405, and in 40 C.F.R. 1500.4 and 1502.7, all EISs 1) for which a bureau is the lead agency and 2) that have not reached the drafting stage shall not be more than 150 pages or 300 pages for unusually complex projects, excluding appendices. Approval of the Assistant Secretary with responsibility for the matter, in coordination with the Solicitor, is required to produce an EIS exceeding the above stated page limitations. In instances of EISs prepared with bureaus serving as co-leads, each responsible Assistant Secretary shall approve any deviations from this policy. To meet the page limitations, each preparer should focus on various techniques such as tiering or incorporation by reference.

(2) To ensure timely completion of EISs, and consistent with the timelines established for major infrastructure projects in E.O. 13807, each bureau shall have a target to complete each Final EIS for which it is the lead agency within 1 year from the issuance of a Notice of Intent (NOI) to prepare an EIS. The initial timeline must be developed by the lead bureau before issuing the NOI in accordance with 43 C.F.R. 46.240, taking into account all relevant timing factors listed therein, including any constraints required by cooperating agencies. An updated timeline should be prepared as needed during the development of the EIS (e.g., at the completion of scoping or if additional time is provided for public comment). Timelines exceeding the target by more than 3 months must be approved by the Assistant Secretary with responsibility for the matter. In instances of EISs prepared with bureaus serving as co-leads, each responsible Assistant Secretary must approve any deviations from this policy.

b. Setting Target Page and Timing Limitations for the Preparation of Environmental Assessments. Within 30 days, each bureau head shall provide to the Deputy Secretary through its supervising Assistant Secretary a proposal for target page limitations and time deadlines for the preparation of environmental assessments. Any common impediments to achieving the proposed targets should also be identified. In developing its proposal, each bureau should consider guidance from CEQ on the page length of environmental assessments. (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 Fed. Reg. 18,026, 18,037, Question and Answer 36a. (Mar. 23, 1981)).

c. Additional NEPA-Streamlining Review.

(1) The Deputy Secretary will coordinate a review of the Department's NEPA procedures to identify additional ways to streamline the completion of NEPA responsibilities. The review will include, but is not limited to, the following areas:

(a) bureau/office NEPA regulations, policies, guidance, and processes to identify: 1) impediments to efficient and effective reviews; 2) best practices and whether they can be implemented more widely; and 3) whether the Department should consider establishing additional categorical exclusions or revising current ones;

(b) requirements and process improvements under Title 41 of the Fixing America's Surface Transportation (FAST) Act, 42 U.S.C. 4370m-1(c)(1)(D), to determine whether any best practices can be broadly applied, including to projects beyond the terms of the FAST Act;

(c) requirements and process improvements required by E.O. 13807, to determine whether any best practices can be broadly applied, including to any projects beyond the terms of E.O 13807; and

(d) CEQ NEPA regulations and guidance to assess whether to recommend changes to facilitate agency processes.

(2) Within 30 days of the effective date of this Order, each Assistant Secretary, in coordination with bureau heads, should provide recommendations for actions to streamline the NEPA process to include potential regulatory revisions, development of revised or additional categorical exclusions, revised or new guidance or policies, and recommendations on streamlining the surnaming process.

d. Implementation of E.O. 13807. The Deputy Secretary will also coordinate implementation of E.O. 13807.

(1) In order to begin implementation of E.O. 13807, each Assistant Secretary, in coordination with the bureau heads, is hereby directed to identify:

(a) potential impediments to efficient and effective reviews for infrastructure and develop an action plan to address such impediments as a subset of the review required in Sec. 4c(1)(a) above;

(b) potential actions that could be taken by CEQ to facilitate a review of major infrastructure projects, as a subset of the review required in Sec. 4c(1)(d) above; and

(c) pending proposals for major infrastructure projects, as defined in E.O. 13807 and that are not yet the subject of a NOI issued by the Department, that could be candidates for the "One Federal Decision" process.

(2) Within 30 days of the effective date of this Order, each Assistant Secretary, in coordination with the bureau heads, should provide the information requested in Sec. 4d(1)(a)-(c) above.

Sec. 5 **Implementation**. The Deputy Secretary is responsible for implementing all aspects of this Order, in coordination with the Solicitor and the Assistant Secretaries.

Sec. 6 **Effect of the Order**. This Order is intended to improve the internal management of the Department. This Order and any resulting report or recommendations are not intended to, and do not, create any right or benefit, substantive or procedural, enforceable at law or equity by a party against the United States, its departments, agencies, instrumentalities or entities, its officer or employees, or any other person. To the extent there is any inconsistency between the provisions of this Order and any Federal laws or regulations, the laws or regulations will control.

Sec. 7 **Expiration Date**. This Order is effective immediately and will remain in effect until it is amended, superseded, or revoked, whichever occurs first.

Deputy Secretary

Date: AUG 31 2017

Coastal Plain Oil and Gas Leasing Program EIS

Internal Scoping Meeting Agenda

May 3, 2018
BLM Alaska State Office, Anchorage, AK
Denali Conference Room

Dial-in Phone: [redacted]
Passcode: [redacted]

Desired Outcomes

- Understanding of program background, purpose and need, proposed action, and overall schedule
- Understanding of the issues of concern
- Identify connected, cumulative, or similar actions with program
- Identify data gaps/data needs
- General EIS outline and content
- Details on external scoping and public meetings
- Next steps and action items

Time	Agenda Item	Facilitator(s)
8:30 – 8:45	Welcome and Introductions	Nicole Hayes and Chad Ricklefs
8:45 – 9:15	Program Overview • Goal of program / kick-off message (BLM/EMPSi) • Summary of program to date / Section 20001 Tax Act (BLM) • Program area and decision space (BLM) • Purpose and need/proposed action (BLM) • Expectations for the EIS / SO 3355 (BLM/EMPSi) • Public scoping • Schedule (BLM/EMPSi)	Nicole Hayes and Chad Ricklefs
9:15 – 10:00	Renewable Resources Issues and Data Discussion. Includes, • Air quality/climate • Water resources/hydrology • Geology/soils/permafrost	BLM/USFWS/SOA/ EMPSi
10:00 – 10:10	BREAK	
10:10 – 11:00	Renewable Resources Issues and Data Discussion. Includes, • Cultural/historic resources • Subsistence • Paleontological resources	BLM/USFWS/SOA/ EMPSi
11:00 – 12:15	Renewable Resources Issues and Data Discussion. Includes, • Vegetation • Wildlife, fish, aquatic species • Special status species • Wildfire	BLM/USFWS/SOA/ EMPSi
12:15 – 1:15	LUNCH	
1:15 – 2:00	Human Environment and Special Designations. Includes, • Recreation • Transportation and access • Noise • Visual	BLM/USFWS/SOA/ EMPSi

Time	Agenda Item	Facilitator(s)
	• Special Designations	
2:00 – 2:45	Non-Renewable Resources. Includes, • Petroleum • Sand and gravel • Hazardous materials	BLM/USFWS/SOA/ EMPSi
2:45 – 2:55	BREAK	
2:55 – 3:45	Socioeconomics. Includes, • Socioeconomics • Environmental justice	BLM/USFWS/SOA/ EMPSi
3:45 – 4:15	Connected, cumulative, or similar actions	Chad Ricklefs
4:15 – 4:30	Next Steps and Actions	Nicole Hayes and Chad Ricklefs
4:30	END FOR DAY	

"(ii) reserves (other than deficiency, contingency, or unearned premium reserves) for life and health insurance risks and life and health insurance claims with respect to contracts providing coverage for mortality or morbidity risks.

"(B) LIMITATIONS ON AMOUNT OF LIABILITIES.—Any amount determined under clause (i) or (ii) of subparagraph (A) shall not exceed the lesser of such amount—

"(i) as reported to the applicable insurance regulatory body in the applicable financial statement described in paragraph (4)(A) (or, if less, the amount required by applicable law or regulation), or

"(ii) as determined under regulations prescribed by the Secretary.

"(4) OTHER DEFINITIONS AND RULES.—For purposes of this subsection—

"(A) APPLICABLE FINANCIAL STATEMENT.—The term 'applicable financial statement' means a statement for financial reporting purposes which—

"(i) is made on the basis of generally accepted accounting principles,

"(ii) is made on the basis of international financial reporting standards, but only if there is no statement that meets the requirement of clause (i), or

"(iii) except as otherwise provided by the Secretary in regulations, is the annual statement which is required to be filed with the applicable insurance regulatory body, but only if there is no statement which meets the requirements of clause (i) or (ii).

"(B) APPLICABLE INSURANCE REGULATORY BODY.—The term 'applicable insurance regulatory body' means, with respect to any insurance business, the entity established by law to license, authorize, or regulate such business and to which the statement described in subparagraph (A) is provided.".

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to taxable years beginning after December 31, 2017.

SEC. 14502. REPEAL OF FAIR MARKET VALUE METHOD OF INTEREST EXPENSE APPORTIONMENT.

(a) IN GENERAL.—Paragraph (2) of section 864(e) is amended to read as follows:

"(2) GROSS INCOME AND FAIR MARKET VALUE METHODS MAY NOT BE USED FOR INTEREST.—All allocations and apportionments of interest expense shall be determined using the adjusted bases of assets rather than on the basis of the fair market value of the assets or gross income.".

(b) EFFECTIVE DATE.—The amendment made by this section shall apply to taxable years beginning after December 31, 2017.

TITLE II

SEC. 20001. OIL AND GAS PROGRAM.

(a) DEFINITIONS.—In this section:

(1) COASTAL PLAIN.—The term "Coastal Plain" means the area identified as the 1002 Area on the plates prepared by

the United States Geological Survey entitled "ANWR Map – Plate 1" and "ANWR Map – Plate 2", dated October 24, 2017, and on file with the United States Geological Survey and the Office of the Solicitor of the Department of the Interior.

(2) SECRETARY.—The term "Secretary" means the Secretary of the Interior, acting through the Bureau of Land Management.

(b) OIL AND GAS PROGRAM.—

(1) IN GENERAL.—Section 1003 of the Alaska National Interest Lands Conservation Act (16 U.S.C. 3143) shall not apply to the Coastal Plain.

(2) ESTABLISHMENT.—

(A) IN GENERAL.—The Secretary shall establish and administer a competitive oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain.

(B) PURPOSES.—Section 303(2)(B) of the Alaska National Interest Lands Conservation Act (Public Law 96–487; 94 Stat. 2390) is amended—

(i) in clause (iii), by striking "and" at the end;

(ii) in clause (iv), by striking the period at the end and inserting "; and"; and

(iii) by adding at the end the following:

"(v) to provide for an oil and gas program on the Coastal Plain.".

(3) MANAGEMENT.—Except as otherwise provided in this section, the Secretary shall manage the oil and gas program on the Coastal Plain in a manner similar to the administration of lease sales under the Naval Petroleum Reserves Production Act of 1976 (42 U.S.C. 6501 et seq.) (including regulations).

(4) ROYALTIES.—Notwithstanding the Mineral Leasing Act (30 U.S.C. 181 et seq.), the royalty rate for leases issued pursuant to this section shall be 16.67 percent.

(5) RECEIPTS.—Notwithstanding the Mineral Leasing Act (30 U.S.C. 181 et seq.), of the amount of adjusted bonus, rental, and royalty receipts derived from the oil and gas program and operations on Federal land authorized under this section—

(A) 50 percent shall be paid to the State of Alaska; and

(B) the balance shall be deposited into the Treasury as miscellaneous receipts.

(c) 2 LEASE SALES WITHIN 10 YEARS.—

(1) REQUIREMENT.—

(A) IN GENERAL.—Subject to subparagraph (B), the Secretary shall conduct not fewer than 2 lease sales area-wide under the oil and gas program under this section by not later than 10 years after the date of enactment of this Act.

(B) SALE ACREAGES; SCHEDULE.—

(i) ACREAGES.—The Secretary shall offer for lease under the oil and gas program under this section—

(I) not fewer than 400,000 acres area-wide in each lease sale; and

(II) those areas that have the highest potential for the discovery of hydrocarbons.

(ii) SCHEDULE.—The Secretary shall offer—

(I) the initial lease sale under the oil and gas program under this section not later than 4 years after the date of enactment of this Act; and

(II) a second lease sale under the oil and gas program under this section not later than 7 years after the date of enactment of this Act.

(2) RIGHTS-OF-WAY.—The Secretary shall issue any rights-of-way or easements across the Coastal Plain for the exploration, development, production, or transportation necessary to carry out this section.

(3) SURFACE DEVELOPMENT.—In administering this section, the Secretary shall authorize up to 2,000 surface acres of Federal land on the Coastal Plain to be covered by production and support facilities (including airstrips and any area covered by gravel berms or piers for support of pipelines) during the term of the leases under the oil and gas program under this section.

SEC. 20002. LIMITATIONS ON AMOUNT OF DISTRIBUTED QUALIFIED OUTER CONTINENTAL SHELF REVENUES.

Section 105(f)(1) of the Gulf of Mexico Energy Security Act of 2006 (43 U.S.C. 1331 note; Public Law 109–432) is amended by striking "exceed $500,000,000 for each of fiscal years 2016 through 2055." and inserting the following: "exceed—

"(A) $500,000,000 for each of fiscal years 2016 through 2019;

"(B) $650,000,000 for each of fiscal years 2020 and 2021; and

"(C) $500,000,000 for each of fiscal years 2022 through 2055.".

SEC. 20003. STRATEGIC PETROLEUM RESERVE DRAWDOWN AND SALE.

(a) DRAWDOWN AND SALE.—

(1) IN GENERAL.—Notwithstanding section 161 of the Energy Policy and Conservation Act (42 U.S.C. 6241), except as provided in subsections (b) and (c), the Secretary of Energy shall draw down and sell from the Strategic Petroleum Reserve 7,000,000 barrels of crude oil during the period of fiscal years 2026 through 2027.

(2) DEPOSIT OF AMOUNTS RECEIVED FROM SALE.—Amounts received from a sale under paragraph (1) shall be deposited in the general fund of the Treasury during the fiscal year in which the sale occurs.

(b) EMERGENCY PROTECTION.—The Secretary of Energy shall not draw down and sell crude oil under subsection (a) in a quantity that would limit the authority to sell petroleum products under subsection (h) of section 161 of the Energy Policy and Conservation Act (42 U.S.C. 6241) in the full quantity authorized by that subsection.

Rapid- Response Resource Assessments and select References
for the 1002 Area of the Arctic National Wildlife Refuge
in anticipation of an Oil and Gas Exploration, Leasing and Development Program
per the Tax Act of 2017 Title II Sec 20001

Prepared by the Alaska Regions of the
US Fish and Wildlife Service and Bureau of Land Management

February 16, 2018

Following the passage of the Tax Act of 2017, the US Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM) and other federal and state agencies organized to evaluate the possible types of decisions that might need to be made to successfully implement an oil and gas program in the 1002 Area of the Arctic National Wildlife Refuge (Coastal Plain). A lead expert from FWS or BLM lead the development of a document (Rapid Response Resource Assessment) that identified i) regulatory or management related decisions that may have to be made, ii) what information is available to support that decision making, iii) possible knowledge gaps and iv) recommended studies or actions to fill any knowledge gaps or improve the best available science. The FWS used the results of the recommended studies or actions sections to help guide funding for FY 2018 towards projects that would be useful for improving future regulatory decision making, mitigating the impacts of seismic exploration and establishing contemporary pre-development baseline data.

The Rapid-Response Resource Assessments capture the results of this effort. The Resource Assessments are not to be considered comprehensive, complete or final, and recommended studies or actions may be added or removed over time as FWS has an increased understanding of how an oil and gas program will be implemented on the 1002 Area of the Coastal Plain and with increased awareness of existing information.

A bibliography of select manuscripts, reports and other publications authored by past and present FWS employees is included. It is not intended to be comprehensive of all research in the 1002 Area of the Coastal Plain.

Discipline/Subject Area: Acoustic Environment

Lead facilitator: Mark Miller, Deputy Director, BLM / North Slope Science Initiative, memiller@blm.gov, 907-271-3212

Individuals contacted for subject-matter expertise:

- Todd Atwood (Research Wildlife Biologist, USGS Alaska Science Center; tatwood@usgs.gov, 907-786-7093)
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What do we need to know and why regarding subjects? Decisions to issue oil and gas leases and to permit development-related activities will indirectly or directly result in the generation of noise (i.e., unwanted sound) that has the potential to impact the acoustic environment and noise-sensitive resources within and adjoining the 1002 Area. Gravel mining (blasting), drilling, and aircraft operations generally produce the highest levels of noise and have the potential to be audible above natural ambient sound levels and disruptive to noise-sensitive resources up to many miles from the noise source, depending on several factors that affect noise propagation and attenuation.

Noise-sensitive resources within and adjoining the 1002 Area include:

- **Wildlife** such as caribou, polar bears, musk ox, and numerous bird species, many of which are important subsistence resources for rural residents;
- **Residents** of Kaktovik, including those engaged in subsistence activities on the coastal plain beyond the village itself;
- **Visitors** to the coastal plain; and

- **Visitors and wilderness values** in congressionally designated Wilderness that borders the coastal plain to the south and east, including opportunities to experience solitude (i.e., the absence of distractions from mechanization, noise, and unnatural light).

Several types of information are needed to understand, assess, and disclose potential impacts on the acoustic environment and noise-sensitive resources, and to provide a basis for decisions about lease stipulations and permit conditions necessary for avoiding, minimizing, or mitigating impacts to the extent possible. (For specific details regarding information needs for noise-sensitive resources themselves, see other sections that address polar bears, caribou, birds, subsistence activities and values, visitors and recreation, and wilderness values.) These information needs include:

- **Baseline (pre-development) acoustic conditions**, including natural ambient sound levels and characteristics of baseline noise conditions such as magnitude, timing, duration, and frequency of occurrence of noise events. The metrics used for characterizing baseline conditions should be those that are most relevant to impact assessment and mitigation, and may vary among different types of noise-sensitive resources. For example, metrics that characterize the frequency and duration of abrupt noise events loud enough to trigger disturbance responses in wildlife and metrics that characterize average hourly noise levels both may be important for describing baseline conditions. Baseline data are required for those specific time periods and specific geographic locations when and where noise from proposed development activities is expected to coincide with periods and locations of high resource sensitivity, considering factors that affect noise propagation and attenuation. Periods and locations of particularly high resource sensitivity may include those associated with:

    - Polar bear denning activities;
    - Caribou calving and post-calving activities;
    - Migratory bird breeding and brood-rearing activities;
    - Kaktovik (all periods of occupancy);
    - Subsistence activities beyond Kaktovik;
    - Visitor use on the coastal plain; and
    - Visitor use in designated Wilderness adjoining the 1002 Area.

- **Acoustic characteristics of specific development-related noise sources**, including typical and maximum magnitude, timing, duration, and number of occurrences during time periods relevant to impact analysis and mitigation (analogous to an air emissions inventory necessary for predictive modeling of development-related impacts on air quality and air quality related values). One-third octave band frequency resolution is preferred.

- **Modeled spatial predictions of acoustic impacts** attributable to development-related noise sources (i.e., noise propagation modeling.) Spatial noise propagation modeling is required for the purpose of estimating how development-related noise would be expected to propagate and potentially impact noise-sensitive resources depending on factors such as noise magnitude, distance

from the noise source, ambient sound levels, atmospheric conditions, and landscape characteristics.

- **Disturbance-response information** that quantitatively or qualitatively characterizes relationships between noise metrics and response metrics for noise-sensitive resources including wildlife, residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness. This information is necessary for assessing, disclosing, avoiding, minimizing, and mitigating potential noise impacts to the extent possible.

  The degree to which noise disturbs and impacts wildlife and people is dependent on many factors. Wildlife responses to noise are known to vary by species, and depend on acoustic factors including the frequency, intensity / magnitude (loudness), and duration of noise; as well as on non-acoustic factors including life-history stage, environmental or behavioral context, and degree of past exposure (Francis and Barber 2013). Noise that is chronic may impact sensory capabilities via masking of biologically important natural sounds such as those used for communication or detection of predators or prey. Noise that is intense and abrupt (therefore unpredictable) may be perceived as a predation threat by prey species such as caribou, potentially triggering a startle response or antipredator behavior such as fleeing. In these cases, the type of disturbance response also may be contingent on whether the noise stimulus is accompanied by an abrupt and threatening visual stimulus, as can be the case with noise events associated with low-flying aircraft.

  As with wildlife, human responses to noise also are contingent both on acoustic and non-acoustic factors. Among the non-acoustic factors are social context and perceived ability to exert control over the noise source (Stallen 1999).

  The special case of aircraft disturbance. Disturbance of subsistence resources (particularly caribou) and subsistence activities by low-flying aircraft associated with oil and gas development has long been an issue of concern to North Slope residents (e.g., see Brown 1979, pp. 38-39). The level of concern has increased over time as use of aircraft to support research and monitoring, recreation, oil and gas development, and other activities on the North Slope has increased during the past few decades.

  Aircraft disturbance of subsistence resources and activities is an issue that involves noise, but is one that is not solely attributable to acoustic factors. Relevant non-acoustic factors include all of those listed above for wildlife and for people. Because of the importance of non-acoustic factors, potential impacts of development-related noise on subsistence resources and activities cannot be assessed only on the basis of acoustic metrics and must be considered in relation to non-acoustic factors as well. For example, BLM staff have noted that subsistence hunters' concern with aircraft disturbance in and near NPR-A is affected by the high degree of uncertainty and unpredictability about where aircraft will be, and therefore by hunters' inability to foresee and avoid aircraft disturbance when engaged in subsistence pursuits (BLM 2017). The spatial unpredictability of aircraft disturbance contrasts with other development-related

disturbances that are predictably associated with gravel roads, pads, and other forms of fixed infrastructure.

The information needed to address this issue is a rigorous, interdisciplinary understanding of the effects of aircraft disturbance (including acoustic factors and contextual non-acoustic factors) on subsistence resources, users, and activities.

- **Long-term acoustic monitoring** to determine actual development-related impacts on the acoustic environment, determine the need for noise-mitigation measures, evaluate the effectiveness of such measures following implementation, and support adaptive management.

What information is currently available to address the information needs for subjects?

- **Baseline acoustic conditions**. During 2010, short-term baseline acoustic data were collected at two sites (Canning River West Bank and Brownlow Spit) in the extreme northwest corner of 1002 Area in support of the Environmental Impact Statement (EIS) for the Point Thomson project (see USACE 2012, Appendix O, Noise Technical Report). Relevant baseline data also were collected at a third site (Coastal Plain) located approximately 2 mi (3.2 km) west of the 1002 Area. In a study conducted in the NPR-A rather than the 1002 Area, Stinchcomb (2017) demonstrated methods for collecting baseline acoustic data, focusing on baseline characterization of aircraft noise events and noise-free-intervals in relation to subsistence resources and activities.

- **Acoustic characteristics of specific development-related noise sources**. Typical noise levels generated by individual pieces of construction equipment and specific construction operations are available online from the U.S. Department of Transportation Federal Highway Administration (USDOT 2006). Recent noise levels for common gas field activities (including active drilling operations) are reported by Ambrose and Florian (2014) based on field data collected in 2013 at locations near the Pinedale Anticline Project Area in Wyoming.

  Noise levels generated by different types of aircraft during different phases of flight operations are available from the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT, https://aedt.faa.gov/), a software system that models aircraft performance for the purpose of estimating emissions, noise, and fuel consumption. Aircraft noise data extracted from the FAA model, previous versions of the model, or similar sources also can be found in a number of publications. Examples include data for a Bell 206 helicopter, a Cessna 207, and a de Havilland DHC-6 Twin Otter (Miller et al. 2003); and a C-130 cargo aircraft (USACE 2004, Appendix H).

- **Modeled spatial predictions of acoustic impacts**. Currently there is no spatial noise propagation information that is specific to anticipated activities, landscape characteristics, and noise-sensitive resources in and adjoining the 1002 Area, although methods used for the Point Thomson EIS are relevant (see USACE

2012, Appendix O; note that aircraft noise propagation was modeled using an FAA model that has since been replaced by the AEDT). Lacking time and technical capacity for spatial noise propagation modeling, BLM (2018) estimated propagation distances for development-related noise by assuming that noise levels would attenuate by 6 dBA for each doubling of distance from the source (Attenborough 2014). This estimation method does not account for potential effects of meteorological conditions, sound barriers, and landscape characteristics on noise propagation and attenuation.

- **Disturbance-response information**. For noise-sensitive resources in and adjoining the 1002 Area, information that relates specific disturbance responses to specific noise metrics are lacking, but several general sources of pertinent information are available. General reviews on the topic of noise disturbance on wildlife include Pepper et al. (2003), Pater et al. (2009), and Shannon et al. (2015). Frid and Dill (2002) and Francis and Barber (2013) provide theoretical frameworks for understanding noise impacts on wildlife, and risk-assessment frameworks for evaluating low-altitude aircraft impacts are provided by Efroymson and Suter (2001) and Efroymson et al. (2001). Stallen (1999) provides a theoretical framework for considering human annoyance with noise.

  Information sources with greater direct relevance to 1002 Area resources include the literature review prepared by Anderson (2007) and several specific papers on caribou responses to low-flying aircraft including Calef et al. (1976), Valkenburg and Davis (1983), and Harrington and Veitch (1991). Murphy et al. (1993; Maier et al. 1998 is the same study) investigated effects of low-altitude military jet aircraft on the Delta Caribou Herd and is the only work that includes actual noise-level data. Lawler et al. (2005) examined effects of low-altitude military jet overflights on the Fortymile Caribou Herd, focusing on the calving season.

  Blix and Lentfer (1992) measured noise and vibration levels resulting from seismic testing, drilling, and transport (including helicopters) in artificial polar bear dens in Prudhoe Bay and concluded that "…the dry and wind-beaten arctic snow muffles both sound and vibrations extremely well and it seems unlikely that polar bears in their dens will be disturbed by the type of petroleum-related activities measured here, providing those activities do not take place within 100 m of the den." But there remains a lack of information about noise levels that are most likely to cause bears to abandon dens, and variation among individual bears also is a factor. There have been instances in which bears have denned immediately adjacent to industrial infrastructure and stayed in the den for the full term. There also have been instances in which dens were abandoned early due to nearby disturbances such as ice-road construction (T. Atwood, pers. comm., 2/13/2018).

  On the topic of aircraft disturbance of subsistence activities, Stinchcomb (2017) concluded on the basis of a meta-analysis of published literature that "…no peer-reviewed literature has addressed the conflict between low-flying aircraft and traditional harvesters in Arctic Alaska" despite extensive evidence that such conflicts are widespread. She speculated that "…the scale over which aircraft, rural communities, and wildlife interact limits scientists' ability to determine causal

relationships and therefore detracts from their interest in researching the human dimension of this social-ecological system."

Christensen and Christensen (2009) reported results of surveys conducted to determine experiences and preferences of visitors to the Arctic Refuge. Although no survey questions addressed the issue of noise *per se*, several questions addressed visitor experiences of and preferences for aircraft use for particular types of activities.

In addition to the Point Thomson EIS and the forthcoming BLM Supplemental EIS for the GMT-2 project, other relevant information sources include impact analyses, stipulations, and best management practices included in the Integrated Activity Plan (IAP) for NPR-A (BLM 2013). Although the IAP did not address noise as a specific issue topic, noise was a factor considered in analyses conducted for several topics related to wildlife and subsistence. The Record of Decision (ROD) for the IAP includes several specific requirements for permitted aviation activities (see Best Management Practice F1, ROD pp. 65-67; also see BLM 2017) that are intended to avoid, minimize, or mitigate aircraft disturbances on wildlife and subsistence activities. These include spatial and seasonal buffers, in addition to minimum flight altitudes (contingent on flight safety considerations).

- **Long-term acoustic monitoring**. No long-term monitoring has been established in the 1002 Area for the purpose of detecting future changes in acoustic conditions and attributing such changes to particular activities including those associated with oil and gas exploration and development.

What are key information gaps?

- **Baseline acoustic conditions**. Baseline acoustic data for the 1002 Area are completely lacking, with the exception of short-term data collected in the extreme northwest corner of 1002 Area in support of the Point Thomson EIS (USACE 2012). Baseline data provide a foundation for long-term monitoring that will be required to support impact mitigation and adaptive management.

- **Acoustic characteristics of specific development-related noise sources**. Although some general acoustic information is available, impact assessment and mitigation actions would benefit from specific acoustic information associated with specific development activities that are anticipated or proposed for the 1002 Area. Such information is analogous to emissions inventory data that are used to support impact analyses and mitigation requirements for air quality and air quality related values.

- **Modeled spatial predictions of acoustic impacts**. Spatial noise propagation modeling that specifically applies to anticipated / proposed development activities and specific landscape characteristics and seasonal atmospheric conditions of the 1002 Area is lacking.

- **Disturbance-response information**. Although much general information is available, specific disturbance-response information is needed to quantitatively or

qualitatively characterize relationships between noise metrics and response metrics for noise-sensitive resources including wildlife (especially caribou and polar bears), residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness.

- **Long-term acoustic monitoring**. To support impact mitigation and adaptive management, long-term acoustic monitoring should be established early during the phased progression of development activities. Baseline data and long-term monitoring are required for those specific geographic locations and specific time periods where and when anticipated / proposed development activities are expected to coincide with high resource sensitivity. Note that long-term monitoring also is lacking in the BLM-administered NPR-A and the nearby village of Nuiqsut despite public concerns over impacts of aircraft disturbance and development-related noise on village residents, subsistence resources, and subsistence activities. This lack of monitoring information has relevance to the 1002 Area, if BLM Best Management Practice F-1 (BLM 2013) is to be considered for application to future development activities in the 1002 Area.

In addition to key information gaps, both BLM and USFWS have significant gaps in the subject matter expertise necessary for credibly and effectively assessing and mitigating impacts of development-related noise on noise-sensitive resources of the 1002 Area.

What studies/surveys need to be conducted to fill those information gaps?

- **Baseline acoustic conditions** should be quantified for those specific geographic locations and time periods where and when anticipated / proposed development activities are expected to coincide with high resource sensitivity (see list above under **What we Need to Know and Why**). Costs will be contingent on the scope of the data collection effort necessary for accurately characterizing baseline acoustic conditions for key locations and time periods. Design parameters such as the number and locations of monitoring sites, and the timing and duration of data collection should be determined jointly by subject matter specialists with expertise in anticipated development activities, specific noise-sensitive resources, and acoustic monitoring and analysis. Based on past work experience, contractors with appropriate acoustic expertise may include HDR Alaska Inc. (contractor for the Point Thomson EIS, including acoustic work), and HMMH, Inc. (a firm with specialized experience in acoustics and Federal projects).

- **Acoustic characteristics of specific development-related noise sources** should be determined through direct measurements of analog noise sources or should be provided by project proponents in the form of a noise emissions inventory for each phase of development.

- **Modeled spatial predictions of acoustic impacts** should be conducted for purposes of impact assessment, disclosure, and mitigation associated with proposed development activities.

- **Disturbance-response research** should be conducted to satisfy specific information needs for understanding, assessing, disclosing, and mitigating impacts of development-related noise on noise-sensitive resources. Priorities for this type of research should be identified in collaboration with subject matter experts for specific noise-sensitive resources.

- **Long-term acoustic monitoring** should be designed and implemented by BLM or USFWS staff (or appropriate cooperators / contractors) with expertise on the topics of acoustic engineering and environmental monitoring. This should be done in close collaboration with subject matter experts for specific noise-sensitive resources. As noted above, long-term acoustic monitoring (or the lack thereof) in NPR-A has potential implications for development planning and impact mitigation in the 1002 Area. Although recent work by Stinchcomb (2017) provides important baseline acoustic data for NPR-A, further acoustic research and monitoring is warranted to determine the effectiveness of Best Management Practice F1 (BLM 2013, pp. 65-67) and aid in evaluating whether alternative or additional practices may be required to minimize effects of low-flying aircraft on subsistence resources, activities, and residents of Kaktovik as phases of oil and gas development progress in the 1002 Area.

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REPORTING TEMPLATE: Air Quality Monitoring and Analysis

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What do we need to know and why regarding Air Quality Monitoring and Analysis?

- Air Quality (AQ) and Air Quality Related Values (AQRV) analyses will be required for oil and gas exploration and development in the 1002 Area of the Arctic National Wildlife Refuge (NWR).

- The **legal basis** for performing AQ and AQRV analyses for industrial activities that may affect federal lands and for operating in the Arctic NWR come from:
  - Clean Air Act (CAA),
  - National Environmental Protection Act (NEPA),
  - Federal Land Policy Management Act (FLPMA),
  - Refuge Improvement Act and the Wilderness Act,
  - Alaska National Interest Lands Conservation Act (ANILCA), and
  - Arctic NWR Comprehensive Conservation Plan (CCP).

- **Guidance and Policy** regarding AQ and AQRV analysis can be found in the:
  - Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report—Revised (2010), and
  - Memorandum of Understanding among the U.S. Department of Agriculture, U.S. Department of the Interior, and U.S. Environmental Protection Agency, Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions through the National Environmental Policy Act Process (June 23, 2011).

- **Sensitive resources:** The Arctic Refuge 1002 area is at the eastern end of the Arctic Coastal Plain, and therefore has similar resources to the NPR-A e.g., lichens and moss, which are important caribou forage during winter and migration. Lichens and moss are particularly sensitive to air pollution. Additionally, the Arctic Refuge coastal plain has:

  - Adjacent designated Wilderness which could be degraded by exploration and development activities;
  - Prevailing NE winds that place it upwind of other Dept. of Interior land management areas, particularly Gates of the Arctic National Park and Preserve;
  - Fish and wildlife resources used for subsistence, including berries, fish, and migratory birds, that may be affected by airborne pollutants;
  - Denning and feeding ESA- and MMPA-protected polar bears, which have demonstrated contaminant loads and may be susceptible to impacts from additional airborne contaminants.

- Interested stakeholders for oil and gas development in the Arctic Refuge include subsistence users, hunters and fishers, river and trekking guides, and the nation's public, who may conclude that oil and gas development in the Arctic 1002 area would permanently and irreversibly disrupt the ecological integrity. This interest may initiate litigation.

- Based on legislation, the maximum extent of surface development footprint is known. Construction and operation activity related to that footprint can reasonably and should be identified.

- AQ and AQRV analyses quantify:
  - Criteria Pollutants (for National and Alaska Ambient Air Quality Standards; NAAQS and AAAQS) Carbon Monoxide (CO), Ozone (O_3), Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Particulate Matter (PM_{10}, and $PM_{2.5}$), Lead;
  - Air Quality Related Values (AQRVs) – impact to visibility and Nitrogen & Sulfur deposition;
  - Air Toxics (Benzene, Formaldehyde, etc.);
  - Greenhouse Gases (GHGs; Carbon Dioxide [CO_2], Methane [CH_4], etc.); and
  - Ultra-fine particulates and Black Carbon (Soot), which are related to changing albedo ("graying" of the Arctic).

- AQ and AQRV analyses are cumulative over the life of a project, so below we discuss Information Needs for three phases:
  - Phase 1: Information needed to develop an Integrated Activity Plan and a lease sale within one year;
  - Phase 2: Information needed for subsequent NEPA processes leading to drilling and production; and,
  - Phase 3: Information needed to protect resources as further exploration, drilling, and production programs proceed.

  For all phases, **information needed** to conduct AQ and AQRV analyses include:
  - Detailed **project descriptions**.
  - **Analysis of current data** sufficiency and evaluation of the need for **additional data collection**, as adequate ambient background concentration data do not exist.
  - Air quality modeling (AQ and AQRV) **modeling and result interpretation**.
  - **Incorporation** of AQ and AQRV results **into the NEPA process**.

Information Needs (by Phase)

Phase 1. Information needed to develop an Integrated Activity Plan (IAP) and a lease sale within one year:

- Key project description elements for seismic exploration or exploratory drilling:
  - Aircraft Information (number, type of planes; number of Landing/Takeoffs(LTOs))
  - Camp Facilities (Camp water maker, heaters, etc.)
  - Fuel Supply and storage
  - Size of operation (e.g., cat train versus drilling rig)

- Adequate data substitutes for background National Ambient Air Quality Standards (NAAQS) and Hazardous Air Pollutant Standards (HAPS) concentrations (no local ambient air quality data exists and could not be collected within one year).

  Especially true for background NO_2 for subsistence hunting, trapping and fishing access.

  - Past modeling efforts in Alaska have found that 1-hour NO_2 emissions can be significant around large drill rigs (e.g. 5 km radius buffer). The 1-hour NO_2 standard was established by the Environmental Protection Agency (EPA) to protect human health. An example of the process (not the data) is previous work on the Kenai NWR.

  - There is also a drill rig workgroup for NO_2 impacts to the Arctic with respect to permitting (http://dec.alaska.gov/air/ap/docs/North-Slope-POGO-Simulation-Modeling-Report-FINAL-2017-10-17.pdf)

- Modeling, interpretation, and review could take 1 week to 1 month depending upon the geographic area, nearby sensitive resources, and and impact of operations (e.g., seismic surveys would be much less than a large exploratory drilling rig).
  Estimated resources needed to complete this work is one to four technical specialist FTE's from BLM or FWS, all of whom have national-level workloads, and assuming data are sufficient and project is clearly defined.

Phase 2. Information needed for NEPA processes leading to drilling and production:

- Project description sufficient for NEPA purposes.

- Ambient air quality data for modeling to determine background AND assessment and tracking of cumulative impacts.
  - Long-term ambient air quality monitoring station data (NAAQS) from Nuiqsut (adjacent to NPR-A) was used for NPR-A draft EIS, but there are no local ambient air quality data available for the Arctic 1002 area.

- Collecting sufficient data to inform the NPR-A draft EIS took two years and utilized considerable BLM/FWS staff, significant contractor assistance, and additional agency (EPA) coordination.

- There is an existing BLM contractor working on the Reasonable Foreseeable Development (RFD) for the Alaska North Slope Air Quality study (NSRAQ study). This work is targeted to be complete by Spring 2019.
    - An estimated $150-200K would be required to to add to the current contract to include the Arctic 1002 project, assuming that it could be modified and a clear funding source is identified.

- AQ and AQRV modeling of air quality impacts using:
    - Near Field Modeling (AERMOD)
    - Far-Field Modeling (North Slope Regional Air Quality Modeling – NS RAQM)

  The worst-case prediction of air quality impacts needed for management decisions can reasonably be modeled.

- Northern Alaska federal lands such as Arctic NWR and Gates of the Arctic (National Park Service) requires quantitative, not qualitative, AQ and AQRV analyses prior to development under NEPA.

- Incorporation of air quality data and modeling results in IAP
    - Typically requires significant contracted assistance (or would require significant additional federal FTEs).
    - BLM and FWS must have control of the contract and would provide the contract requirements, technical input and perform the final review.
    - Contract option time frame of 24 to 30 months: initiating and awarding contract (3-4 months); complete contract work (12-15 months); review (3-6 months); incorporating work into NEPA document (3 months).

Phase 3. Information needed to protect resources during drilling and production.

- Sensitive resources specific to lease area
- Specific project development descriptions
- Likely, additional site-specific AQ and AQRV analyses
- Further developments of near-field Modeling (AERMOD) and far-Field Modeling (North Slope Regional Air Quality Modeling – NS RAQM)
    - Recent analyses examples include NPR-A Greater Moose's Tooth (GMT)-1 and GMT-2, and the proposed Willlow project. (1002 area project size is similar to Alpine, but that analysis is out-of-date and timeline or costs would not be accurate for the 1002 development.)

What information is currently available to address the information needs for subjects?

- Short-term: The process (not data) used for air impact evaluation for oil and gas development on the Kenai NWR could be used to initially analyze NO_2 impacts for seismic and exploratory drilling.
- Longer-term: Current projects in NPR-A, including GMT-1 and GMT-2 have existing near- and far-field AQ and AQRV analyses, but these would need to be expanded in scope and include location-specific ambient air quality data.

What are key information gaps?

- A clear project description that details the Reasonable Foreseeable Development (RFD). With the RFD estimate, additional high, medium or low projection are created to characterize the future potential development.

  For each stage (exploration, construction/drilling, production), project descriptions need to include:
    - number, size, and highest probability location of wells
    - number of pads
    - estimates of air emissions
    - number and location of roads
    - specific and auxiliary equipment used
    - supplemental power used (fuel, storage)
    - control technologies used
    - construction activity and equipment used
    - geographic proximity of sensitive resources
    - topography
    - emission magnitude

- Additions to current near-field and far-field modeling to include the Arctic 1002 area.

- Ambient air quality monitoring in the Arctic 1002 area and downwind (minimum of NAAQS, $PM_{2.5}$, and Prevention of Significant Deterioration (PSD)) to address cumulative impacts and support accurate modeling.

    Kaktovik residents who use the 1002 area for subsistence and other stakeholders will benefit from a long-term NAAQS air quality monitoring station (and potentially HAPS, based on Nuiqsut requests for NPR-A development) within or downwind of the Arctic 1002 area to alleviate concerns regarding air quality impacts to the community from development.

What studies/surveys need to be conducted to fill those information gaps?

- Far-field (North Slope Regional Air Quality Modeling – NS RAQM) and Near-field modeling (AERMOD) will need to be modified to incorporate the Arctic 1002 area, through extension of a current BLM contract, a new agency contract, or with additional agency personnel.
    - While not an information need *per se*, the time necessary to oversee, conduct, and incorporate needed additional air quality modeling will be significant. This includes adherence to Request for Proposal and contract processing times.

- Establish long-term NAAQS ambient monitoring stations in or near Arctic 1002 area and downwind in sensitive areas, including monitoring and study sites. Per site, equipment and startup costs = $500K and annual costs = $250-300K, depending on location, logistics, and availability of operators.

- Evaluate adequacy of current data sources to meet some needs, especially for Phase 1:
    - satellite data (e.g., validation of NO_x plumes from Prudhoe Bay, average patterns of potential pollution dispersion)
    - Limited NOAA/NWS/FAA data
    - BLM ozone study in NPR-A
    - Toolik Lake Field Station research
    - Industry-sponsored PM speciation studies at Wainright and Deadhorse.

- Establish “Interagency Monitoring of Protected Visual Environments” (IMPROVE) data collection at Toolik Research Station and a coastal site. Equipment cost =$20 - 30K and annual cost per site = $37K (2018 dollars).

- Establish ethane/methane monitoring station at Tooklik, which will help in source attribution of methane from industrial activities.

COASTAL PLAIN 1002 AREA: BIRDS

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What do we need to know and why regarding subjects?

The Coastal Plain of the Arctic National Wildlife Refuge (hereafter Refuge) and adjacent marine waters (including the 1002 area) are recognized as Important Bird Areas (IBA) by the American Bird Conservancy, Audubon, and Birdlife International. Prior studies have demonstrated the value of the coastal plain 1002 area to both breeding and non-breeding birds. During the short Arctic summer, millions of shorebirds, waterfowl, loons, gulls, and landbirds use the 1002 Area. At least 158 species of birds have been recorded on the coastal plain of Arctic Refuge, and birds that use the Refuge have ranges that include all 50 U.S. states and 6 continents. Of the 57 species known to regularly occur in the 1002 Area, 24 are USFWS Birds of Management Concern, 14 are USFWS Alaska Region Priority Species, and 10 are listed as Near Threatened or Vulnerable by the International Union for Conservation of Nature or are on the Audubon Red List. Two species listed under the provisions of the Endangered Species Act have been reported in the 1002 Area, although only spectacled eiders are known to currently reside and breed there.

Purposes of the Refuge, as established by the Alaska National Interest Lands Conservation Act (ANILCA), include:

- “to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to…snow geese, peregrine falcons and other migratory birds”;
- “to fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats”;
- “to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents”;

Applicable international treaties include the Migratory Bird Treaty. Other authorities under which we manage and conserve birds on the Refuge include the Endangered Species Act, the Bald and Golden Eagle Protection Act, and the Refuge Administration Act of 1966 as amended by the Refuge Improvement Act of 1997.

Conservation of birds in association with exploration, development, and production of oil and gas resources in the 1002 Area of the Coastal Plain of the Refuge will require information regarding:

- o Contemporary abundance and distribution of breeding and non-breeding birds in the 1002 Area, with particular attention to identification of important nesting, feeding, and molting areas;
- o Phenology and patterns of seasonal movement by breeding and non-breeding birds in the 1002 Area; and
- o Impacts of development and disturbance to birds using the 1002 Area (including pre-development baseline data) during sensitive time periods, with special consideration given to how the dissimilarities in water availability between the 1002 Area and areas like Prudhoe Bay and National Petroleum Reserve – Alaska (NPR-A) may lead to differential impacts.

What information is available to address information needs and what are the remaining gaps?

1. Resource Inventories

Bird abundance and distribution information for the 1002 Area will help define the areas that are most important for species, or groups of species, and can therefore help define conservation and management priorities.

1.1 Historical surveys for breeding and non-breeding birds

Surveys in the late 1970s through mid-1980s in the 1002 Area included site-specific ground-based tundra breeding bird surveys on the coast and inland, breeding and post-breeding bird surveys on barrier islands and in lagoons, aerial breeding swan surveys, aerial- and ground-based breeding raptor surveys, and post-breeding snow goose surveys. Although these data provide important historical information about the bird resources of the 1002 Area, abundance and distribution for many species has likely changed as it has on the broader Alaska Coastal Plain over the intervening 40 years.

1.2 Recent surveys of breeding birds

- o Ground-based surveys of breeding shorebirds were conducted throughout the 1002 Area during summer 2002 and 2004. That work found higher shorebird density in wetlands and near the Canning River Delta. Although surveys were informative, some species were encountered in low numbers, making distribution and abundance estimates unreliable.
- o Aerial surveys of waterbirds, including waterfowl, loons, and gulls, have been conducted annually across much of the Alaska Coastal Plain since the mid-1980s. However, only about 1/4th of the 1002 Area is included, and what is surveyed is done so at the lowest intensity, making estimates of waterbird abundance and distribution for the 1002 Area unreliable.
- o Aerial breeding bird surveys (primarily for common eiders) were conducted on barrier islands in summer 1999-2009. Ground-based surveys were conducted in summer 2003/04 and 2014-17. Aerial survey estimates were variable between years. Ground surveys revealed breeding common eider abundance on the barrier islands may have increased significantly between 1976 and 2017.
- o Breeding cliff-nesting raptors were periodically surveyed in the Brooks Range, foothills, and 1002 area in the 1990s and early 2000s. Overall abundance of nesting raptors was generally low in the 1002 Area.

1.2.1 Site-specific surveys of breeding birds

The Canning River Delta on the western edge of the Refuge Coastal Plain is the only site within the 1002 Area for which contemporary, fine spatial scale breeding bird data are available. Intensive surveys focused on shorebird breeding abundance were conducted in

1979-80, 2002-07, and 2010-11. Some waterbird and passerine abundance data were also collected. This site has provided significant information on habitat use patterns and variation in phenology of tundra nesting shorebirds, passerines, waterfowl, and loons. The long-term data collected at the site also provide information on trends in abundance for birds breeding in the 1002 Area, including an apparent 15-fold increase in cackling geese since 1980.

1.3 Recent Surveys of non-breeding birds

- Boat- and ground-based coastal shorebird surveys were conducted during fall staging and migration at the major river deltas, 2006-2011. These investigations found the vast majority of shorebirds using the surveyed deltas were juveniles.
- Aerial fall-staging snow geese surveys occurred in the 1990s and early 2000s. Up to 325,000 snow geese were estimated to use the Refuge Coastal Plain in some years.
- Lagoon and near-shore surveys of post-breeding and molting waterbirds were conducted during fall 2002-2003. Up to 20, 28, 29, 33, and 41% of the yellow-billed loons, red-throated loons, long-tailed ducks, scaup, and pacific loons, respectively, counted during the entire Alaska North Slope survey occurred along the Refuge coast.
- Adults of three species of shorebirds were tagged at four sites on the ACP (including two species at one site in the 1002 Area) with GPS loggers to document use of stopover sites along the Beaufort Sea coast in summer 2017, but tagging of more individuals and species is needed before assessments can be completed.

1.4 Resource inventory gaps for breeding and non-breeding birds

Most of the current information on bird abundance and distribution in the 1002 Area was collected for only one or two years, covers only a small portion of the 1002 Area, and/or was collected at low survey intensity. In addition, the 1002 Area contains far fewer waterbodies compared to sites further west (e.g., within NPR-A), therefore birds are likely more patchily distributed. Contemporary information on bird abundance and distribution patterns in the 1002 Area are needed, especially considering that many shorebirds (either at the species or sub-species level) are declining, some goose species are increasing broadly across the North American Arctic, and habitats are changing across the Arctic Coastal Plain due to warmer, longer summers.

2. Phenology

The timing of key life events (phenology) is a critical part of nearly every important ecological relationship. For birds, the phenology of arrival, nesting, brood-rearing, and staging prior to migration likely coincides with availability of critical food and other resources. Understanding bird phenology in the 1002 Area may facilitate mitigation by conducting exploration and development activities during periods when birds are less reliant on specific areas and habitats.

2.1 Status of phenology information for 1002 Area birds

- A large amount of information on the timing of breeding is available for tundra-nesting birds from across the Alaska Coastal Plain (including the Canning River Delta), and may be reasonably extrapolated for general approximations to the 1002 Area.
- Phenological data are available for juvenile shorebirds using the 1002 Area river deltas in the late summer and fall, although substantial differences in timing among sites was detected.
- Some phenology information is available for molting sea ducks and waterbirds using coastal lagoons from studies in the 1980s, but surveys were generally conducted only a few times across several months, therefore the range in timing of peak use is not known.

- Reasonably good information is available on the general phenology of snow geese using tundra areas during fall staging from studies conducted through the early 2000s.
- Raptor phenology is fragmented and limited to observations of birds on nests during surveys along major rivers during the 1990s and 2000s.
- Adults of a few shorebird species were tagged in summer 2017 with GPS loggers at the Canning River Delta. These devices may provide phenology data for the post-breeding season if recovered.

<u>2.2 Information gaps for bird phenology</u>

- Although surveys have demonstrated the importance of the Refuge lagoons for waterbirds, there is poor understanding of the phenology of their use of this habitat. In addition, climate-mediated changes to the Beaufort Sea nearshore areas may be affecting benthic prey communities and ice conditions, and therefore the timing of when birds use the lagoons could be affected.
- Post-breeding phenology of adult shorebirds using the 1002 Area is poorly understood, and so far, the only data available from recently deployed tracking devices are for buff-breasted sandpipers from breeding locations to the west of the Refuge.
- The amount of time birds remain at key stopover sites is virtually unknown for most birds using the 1002 Area. These data are important for calculating disturbance or displacement risk and determining seasonal abundance estimates.

3. Potential impacts of development and disturbance

Oil and gas development may impact breeding and post-breeding birds through building and line strikes, loss or alteration of habitat, increased predator abundance, disturbance, and contamination.

<u>3.1 Knowledge on impacts to birds from oil and gas development and disturbance</u>

Numerous studies have been conducted on the impacts of development and disturbance to nesting and non-breeding birds at Prudhoe Bay and in NPR-A since the 1970s. Additionally, several studies on the potential impacts of industrialization and disturbance to birds were conducted in the 1002 Area. Results of some projects focused on impacts to birds can be found in summary documents, including the Refuge Coastal Plain Resource Assessments and Updates (e.g., Garner and Reynolds 1986, Garner and Reynolds 1987), Refuge Coastal Plain Terrestrial Wildlife Research Summaries (Douglas et al. 2002, Pearce et al. 2018), and the National Research Council report on the cumulative environmental effects of oil and gas activities on Alaska's North Slope (National Research Council 2003).

<u>3.2 Information gaps for potential impacts to birds from oil and gas development and disturbance</u>

- Before an assessment of potential impacts of development can be conducted, better information on abundance, distribution, habitat use, and phenology of breeding and non-breeding birds in the 1002 Area is required. Therefore, the topics below only address the most apparent immediate needs.
- The extent to which wetlands will be lost due to water use for oil and gas development needs to be better understood to evaluate impacts on birds. Exploration and development activities generally require substantial volumes of freshwater, but the 1002 Area contains less than 1/10^{h} the density of lakes compared to areas to the west where oil and gas activities are ongoing. In addition, 1002 Area lakes tend to be shallower and freeze to the bottom during winter. Therefore, wetlands and waterbodies, especially where clustered, have high value for birds inhabiting the 1002 Area. Because of this, activities that affect the

availability, seasonality, or flow of water could have different effects on birds, their habitats, and their foods in the 1002 Area compared to areas further west, but how and to what extent is unknown.

- Changes in the avian predator community makeup, predator abundance, and impacts to avian productivity are some of the most commonly described consequences of industrial activity for birds breeding on the Alaska Coastal Plain. Shelter associated with winter exploration activities may attract predators such as arctic fox and raven. Little is known about the contemporary predator community makeup or abundance in the 1002 Area.
- Limited contemporary exposure data for birds are available for contaminants related to oil and gas development in the 1002 Area.

What studies/surveys need to be conducted to fill information gaps?

- Conduct aerial- or ground-based inventories of breeding birds. Species groups should include waterfowl, loons, gulls, shorebirds, and landbirds and should also include both area-wide and site-specific surveys. These data will provide contemporary information on distribution and abundance and help identify important areas for birds. Prioritization of surveys should be based on conservation needs. Because this information may be important to leasing, and because year-to-year variability will require baseline data to be collected over several years, surveys should begin as soon as possible.
- Conduct aerial- or ground-based inventories of Brooks Range, foothills, and Coastal Plain rivers for breeding cliff-nesting raptors. Because raptors may begin using the Coastal Plain while winter exploration activities occur, these surveys/studies should begin in the near future.
- Conduct surveys to estimate abundance and distribution of predators of birds and eggs. Additional studies should also be conducted to determine current makeup of nest predators for common or sensitive bird species, and gather baseline information on movement patterns of foxes in the 1002 Area. Because high annual variability will require baseline data to be collected over many years, surveys and studies should begin as soon as practical.
- Conduct studies on the foraging ecology of nest predators and how individuals choose food items and adjust diet patterns based on alternative prey. Objectives should target ways to inform potential management actions if local predator abundance is found to increase in response to oil and gas related activities.
- Determine post-breeding abundance, distribution, habitat use, and phenology of waterfowl and loons in lagoons, and of shorebirds in deltas and coastal areas. Prioritization should be based on species' conservation need and sensitivity to disturbance and development.
- Investigate how water availability and the patchiness of waterbodies in the 1002 Area affects how disturbance and development may impact birds.
- Update baseline contaminant exposure information for birds breeding in the 1002 Area and using deltas and lagoons for fall staging, with particular emphasis on hydrocarbon exposure and how contaminant burdens may affect reproduction, survival, and subsistence value and human health.
- The above studies should incorporate how predators and birds adjacent to the 1002 Area may change their behavior in response to activities directly associated with 1002 Area oil and gas development.
- Much of the data from surveys and studies conducted in the 1002 Area are not widely available. The Refuge is working with FWS Science Applications to build a publically accessible database for the long-term dataset for the Canning River Delta tundra nesting bird project. Comparable efforts should follow for other projects to ensure appropriate storage and management of important data and allow for public data access to both contemporary and historical data.

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Garner, G.W., and P.E. Reynolds. 1986. Arctic National Wildlife Refuge coastal plain resource assessment: final report baseline study of the fish, wildlife, and their habitats (3 volumes). Anchorage, AK: U.S. Department of the Interior, Fish and Wildlife Service, Alaska Region.

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Pearce, J.M., P.L. Flint, T.C. Atwood, D.C. Douglas, L.G. Adams, H.E. Johnson, S.M. Arthur, and C.J. Latty. 2018. Summary of wildlife-related research on the coastal plain of the Arctic National Wildlife Refuge, 2002-17. Reston, VA: U.S. Department of the Interior, Geological Survey Open-file Report 2018-1003.

REPORTING TEMPLATE

- **Discipline/Subject Area: Caribou**

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- **What do we need to know and why regarding subjects?**

The purposes of the Arctic National Wildlife Refuge, as established by the Alaska National Interest Lands Conservation Act include:

- "to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, the Porcupine caribou herd (including participation in coordinated ecological studies and management of this herd …);
- "to fulfill the international fish and wildlife treaty obligations of the United States";
- "to provide the opportunity for continued subsistence uses by local residents";

In addition, the International Agreement for the Conservation of the Porcupine Caribou Herd (1987) obligates the governments of the United States and Canada to:

- "conserve the Porcupine Caribou Herd and its habitat through international co-operation and coordination so that the risk of irreversible damage or long-term adverse effects as a result of use of caribou or their habitat is minimized";
- "ensure opportunities for customary and traditional uses of the Porcupine Caribou Herd" by rural Alaska residents and members of Canadian First Nations;

Conservation of the Porcupine caribou herd in association with the exploration, development, and production of oil and gas resources on the coastal plain of the Arctic Refuge will require information regarding:

- Importance of the 1002 Area relative to caribou birth rates, calf survival, and overall herd health;
- Likelihood and consequences of disturbance or displacement of caribou from the 1002 Area (or portions thereof) during calving and post-calving seasons;
- Potential impacts of development on access to caribou by hunters and on viewing opportunities of other Refuge visitors;

➢ **What information is currently available to address the information needs for subjects?**

- The Porcupine caribou herd occupies a range of approximately 130,000 square mi (337,000 square km) spanning the border between Alaska and Canada. The herd is an important cultural and economic resource utilized by local and indigenous people in Alaska and the Yukon and Northwest Territories of Canada. Approximately 2,000 – 3,000 caribou are harvested annually, mostly by subsistence users. In addition, viewing the large aggregations of caribou that occur during summer is a unique experience valued by visitors from across the U.S. and around the world.
- Telemetry data from collared adult female caribou from the Porcupine herd have been collected since 1982. These data indicate that this herd migrates to the Arctic coastal plain of northeastern Alaska and northwestern Canada for calving during early June. The area used for calving for all years combined extends approximately from the Canning River in Alaska to the Babbage River in Yukon Territory, Canada and includes the 1002 Area of the Arctic Refuge. Additional aerial surveys conducted over the coastal plain beginning in the 1960s, and surveys of relative abundance of bone and antler specimens on the tundra dating back to the early 20th century confirm that this area has been used for calving for many decades, and likely for millennia. Annual distributions of caribou during the calving season have varied among years; however, the highest densities of calving caribou were within the central coastal plain of the Arctic Refuge, including the 1002 Area, during many years.
- Predator densities are lower within areas of the coastal plain used for calving compared to neighboring areas in the foothills of the Brooks Range.
- Availability of high-quality food plants consumed by caribou during the calving season is greater within the calving range than in neighboring areas to the south and east.
- Modeling the potential effects of displacement of the caribou calving range from the coastal plain suggested that this would expose caribou calves to higher rates of predation and lower quality forage.

- During 1982-1998, caribou from the Porcupine herd used the 1002 Area and neighboring coastal areas of the Arctic Refuge for insect relief habitat during late June and early July of most years. From 1999-2017 caribou moved through this area after calving but the duration of use was variable and generally shorter than during the previous period, and most caribou moved south into the Brooks Range or east into Canada during early July.
- All arctic caribou herds fluctuate in size over periods of several decades. However, the rate of change (both increase and decline) of the Porcupine herd has been slower than other herds in arctic Alaska. The herd increased slowly during the 1980s, reached a peak of 178,000 in 1989, declined to approximately 123,000 in 2001, then increased to its current population of 218,000 in 2017.
- Studies of the Central Arctic caribou herd in developed areas west of the Arctic Refuge suggested that pregnant female caribou avoided roads and other oil field infrastructure during the calving period. Avoidance of infrastructure was less evident or absent among non-pregnant females and males. Caribou were more tolerant of human disturbance during mid to late summer, when caribou movements are largely driven by insect harassment. When human activity is low, caribou may even seek out raised gravel pads, roads, or structures to escape insect harassment.
- Prior to development, the area surrounding Prudhoe Bay was used by Central Arctic caribou for both calving and as insect relief habitat. The intensive development that occurred in this area apparently caused caribou to shift their calving distribution southward, and to cease using the developed area for forming the large aggregations that occur in response to insect harassment. Caribou seem to be more tolerant of the lower density of infrastructure associated with more recent installations west of Prudhoe Bay and have continued to use developed areas near the Kuparuk and Milne Point oil fields for insect relief.
- Displacement of Central Arctic caribou from preferred calving areas near Prudhoe Bay was associated with reduced calf size at birth, but the difference was not sufficient to cause a statistically detectable reduction in calf survival.
- Elevating pipelines to a minimum of seven feet above ground and separating roads and pipelines by at least 300 feet reduced the impact of linear features that might obstruct caribou movements.
- Despite any negative impacts that might have occurred during the period of development, the Central Arctic caribou herd grew from approximately 10,000 caribou in the late 1970s to a peak population of 70,000 in 2010. The herd subsequently declined to 22,000 in 2016.

➢ **What are key information gaps?**

Much of the available information regarding effects of oil field development on caribou came from studies of the Central Arctic herd during the 1980s and 1990s. These studies did not utilize the sophisticated analytical methods that have been developed since then, and most were limited to documenting large-scale distribution

patterns, comparing density of caribou at varying distances from infrastructure, and observing changes in caribou numbers over time. In addition, many studies were of limited duration and had low statistical power to detect differences in demographic rates (survival, reproduction, and population change). Because of the variety of natural factors that drive caribou demographics (e.g., variation in climate, weather, forage quality, predator abundance) and the general tendency of caribou herds to fluctuate in abundance, these studies provide only limited information to evaluate the potential impacts of development on the Porcupine caribou herd. Furthermore, there are significant geographic differences between the ranges of the Central Arctic and the Porcupine herds. For example, the coastal plain used for calving by the Central Arctic herd extends up to 100 mi (160 km) inland from the Arctic coast to the foothills of the Brooks Range; whereas, the coastal plain used by the Porcupine herd is only 10-40 mi (16-64 km) wide and contains a much smaller proportion of moist and wet sedge tundra habitat used by caribou for feeding during early summer. These differences suggest that impacts on the Porcupine herd could be greater due to the relative scarcity of alternative calving and post-calving habitat within the range of that herd. Key information gaps include:

- Estimated rates of survival and recruitment are not sufficiently precise to detect biologically significant differences among years;
- Lack of understanding of what drives the variation in calving site selection by caribou;
- Little empirical data are available concerning the potential physiological and demographic effects of displacement of caribou from preferred calving and insect relief habitats (e.g., evaluate the value of the 1002 Area in providing higher nutrition, reduced predation, and access to insect relief habitat in comparison to other areas).
- Data are needed to assess effectiveness of existing measures used to mitigate effects of disturbance on caribou and to develop more cost-effective measures;
- Research is needed to differentiate the effects of disturbance from natural variation in caribou distribution, abundance, and demographic parameters;.
- Limited understanding of how interchange of caribou between neighboring herds might affect population dynamics of those herds.

What studies/surveys need to be conducted to fill those information gaps?

Exploration phase:

- <u>Increase demographic/behavior monitoring</u>: To improve precision of estimates of survival, birth rates, and recruitment so that changes in important demographic parameters can be detected, monitoring intensity should be increased (number of radiocollared caribou and monitoring effort). This monitoring should use GPS collar technology so that fine-scale behavior data can simultaneously be collected, increasing the ability to understand the influence of habitat conditions on demography. Such data would also reveal emigration rates to neighboring

herds. Increased field monitoring would also facilitate the following proposed studies (potential cost: $75,000-$100,000 annually);

- Assess factors associated with calving site selection: Identify and evaluate the relative importance of climate, predator abundance, forage quality, insect harassment, population density, and anthropogenic disturbance on calving site selection using a combination of long-term and newly collected data; Estimated cost: $75,000 annually for 5 years. Should be done during exploration period so that impacts of future development can be differentiated from natural drivers.
- Investigate characteristics associated with post-calving distribution: Use long-term and newly collected data to understand the influence of weather, forage conditions, insect harassment and population density on caribou movement and resource-selection patterns during the post-calving period. Estimated cost: $150,000 annually for 5 years. This information will be needed during the development phase to guide design and placement of infrastructure.
- Analyze existing telemetry data to quantify seasonal ranges and migration routes: A large database of telemetry data exists that could provide valuable baseline information on caribou movements. These data need to be formally analyzed to update the report "Sensitive Habitats of the Porcupine Caribou Herd" (International Porcupine Caribou Board, 1993). Estimated cost: $25,000 (seasonal salary; no costs other than staff time); this information is needed to identify sensitive areas that may require special management during development and production.
- Monitor body condition and survival: Existing long-term monitoring programs should be continued to predict population trends and evaluate the roles of natural vs. anthropogenic factors. These data will be needed to evaluate causes of future changes in population size that are likely to occur during the development and production periods.

Development and production phase:

- Continue monitoring caribou movements: Monitoring data are needed to identify calving areas and seasonal ranges and to quantify caribou recruitment and survival; Estimated cost: $250,000 annually, collaboration with state, federal, and Canadian agencies, cost sharing to be determined.
- Identify drivers of caribou fitness traits (body condition, survival and recruitment): Use long-term and newly collected data on collared individuals to quantify the effects of annual variation in summer and winter forage conditions (vegetation type, nutritional condition), weather (phenology, snow depth and density, icing events), predator abundance, population density, insect harassment and human activity on caribou body condition, survival and recruitment; Estimated cost: $200,000 annually for 5 years. This information will be needed to differentiate potential effects of displacement from variation due to natural causes, to evaluate mitigation measures that are applied, and to develop improved mitigation strategies.
- Monitor body condition and survival: Long-term monitoring of basic physiological and demographic traits is necessary to predict population trends and evaluate

the roles of natural vs. anthropogenic factors. These data will be needed to evaluate causes of future changes in population size that are likely to occur during the development and production periods.

- Project future changes in distribution and demography: With an improved understanding of the factors that influence the behavior and demography of Porcupine caribou (see previous needed studies), the influence of development within the 1002 Area on the herd can be projected, along with expected future changes in other key factors (i.e., climate, insect harassment, forage conditions). Estimated Cost: Analysis time after the other studies have been completed.

REPORTING TEMPLATE

Discipline/Subject Area: Coastal resources

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What do we need to know and why regarding subjects? We discussed that decisions affecting/involving coastal resources would include the following resource development issues: sea ice roads, sea ice airstrips, barge access, coastal infrastructure (e.g. pads, pipelines, docks), water treatment (desalinization input/output; other discharges), offshore gravel resources.

To address these issues, we need to understand:

1. Sea ice dynamics
2. Coastal erosion
3. Coastal & Barrier Island geomorphology
4. Coastal bathymetry
5. Coastal habitats
6. Coastal water quality and chemistry

What information is currently available to address the information needs for subjects?

1. Sea Ice Dynamics: Understanding the timing and duration of sea ice may affect seasonal access.
    a. Studies conducted, underway and proposed by Beaufort Lagoon Ecosystem LTER, which includes the Kaktovik and Jago Lagoons.

i. Open-access Synthetic Aperture Radar from the Sentinel-1a satellite will be used to monitor ice formation and breakup conditions throughout the Alaska Beaufort Coast.

ii. Time lapse cameras and meteorological stations on 3-meter towers adjacent to each lagoon system to capture freeze-up, break-up and ice-out (220° field of view with red, green, blue, infrared and thermal imagery) and measure air temperature, atmospheric moisture, wind speed and direction, soil temperature and moisture, photosynthetically active radiation, and atmospheric pressure

b. Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort Sea to understand the spatial and temporal distribution of sea ice and leads in support of coastal access and wildlife habitat.

i. Mahoney, A., H. Eicken, L. Shapiro, R. Gens, T. Heinrichs, F. Meyer, and A. Graves-Gaylord. 2012. **Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort and Chukchi Seas. Final Report.** OCS Study BOEM 2012-067, University of Alaska Fairbanks and USDOI, BOEM Alaska OCS Region, 154 p. https://marinecadastre.gov/espis/#/search/study/7020

2. Coastal erosion: Coastal erosion will affect lands available for leasing, infrastructure siting, and potentially access from land to sea and vice versa. Rates of erosion available every 50m for Arctic Refuge from USGS Change for entire coastline of Arctic Refuge published in 2015

a. Gibbs, A.E., and Richmond, B.M., 2015, National assessment of shoreline change—Historical shoreline change along the north coast of Alaska, U.S.–Canadian border to Icy Cape: U.S. Geological Survey Open-File Report 2015–1048, 96 p.

b. Lidar along entire coast was acquired between 2009-2012, and are incorporated into an updated report

i. https://pubs.er.usgs.gov/publication/ofr20171107

ii. GIS data: https://www.sciencebase.gov/catalog/item/57e96bd2e4b09082500c91b0

3. Coastal & Barrier Island geomorphology: Understanding the coastline will be important if access to the refuge from offshore ice or waters is desired and to inform erosion modeling. Barrier islands take the brunt of storm impacts and erosion, especially at inlets. Critical to protecting erodible coastline. The

USGS led a study to evaluate barrier island stability and projected change. Overall, elevational data for the coastline is sufficient; however morphology data could be better and is the focus of several ongoing and newly initiated projects.

a. General descriptions of coastline in Gibbs, A.E., and Richmond, B.M., 2015, National assessment of shoreline change—Historical shoreline change along the north coast of Alaska, U.S.–Canadian border to Icy Cape: U.S. Geological Survey Open-File Report 2015–1048, 96 p., http://dx.doi.org/10.3133/ofr20151048.
    i. Updated report: https://pubs.er.usgs.gov/publication/ofr20171107
    ii. GIS data: https://www.sciencebase.gov/catalog/item/57e96bd2e4b09082500c91b0
b. Historical shoreline change rates dating back to 1947 and computed from T-sheets, satellite imagery, and airborne lidar were used to assess the stability of the mainland shores and Arey Island. In order to evaluate future stability and the ability of Arey Island to mitigate wave energy delivery to the lagoon, hindcast (probable past conditions: 1981-2010) and future coastal storm conditions (2011-2100) were simulated with a suite of numerical models. Model simulations were further used to quantify anticipated changes in flood frequency, duration, and extent of Arey Island and coastal wet sedge areas along the mainland shores of Arey Lagoon.
    i. Erikson, L.H., Gibbs, A.E., Richmond, B.M., Storlazzi, C.D., Jones, B.M., Ohman, K.A., 2018, Changing Storm Conditions in Response to Projected 21st Century Climate Change Scenarios and thePotential Impact on an Arctic Barrier Island –Lagoon System: A Pilot Study for Arey Island and Lagoon, Eastern Arctic Alaska, U.S. Geological Survey Open File report, *in press.*
c. NOAA Shorezone, includes imagery for coast and barrier islands, classifications https://alaskafisheries.noaa.gov/
    i. Length of homogenous shoreline unit
    ii. Habitat classification
    iii. Biological Wave Exposure
    iv. Oil Residency Index
    v. Coastal Classification
    vi. Environmental Sensitivity Index (substrates)
d. Studies conducted, underway and proposed by Beaufort Lagoon Ecosystem LTER, which includes the Kaktovik and Jago Lagoons.

        i. Annually for each lagoon and once every 5 years for the entire Beaufort Sea Coast, coastline and barrier island position and morphology will be digitized from high spatial resolution pan-sharpened orthorectified WorldView2 satellite imagery acquired at no cost from the Polar Geospatial Center.

4. Coastal bathymetry: This information is needed to understand seafloor morphology/depth, gravel deposits and identify habitat for coastal species out to approximately 20m water depth. Bathymetry was last completed in 1940's. Industry has done work in their areas of interest, but not offshore of 1002 area.
5. Coastal habitats: Impacts of coastal activities, desalinization/discharge could affect coastal ecosystems, including habitats that Threatened and Endangered Species depend on as well as fish and migratory birds.
    a. NOAA Shorezone, including habitat classification for coast and barrier islands, classifications https://alaskafisheries.noaa.gov/
    b. Studies conducted, underway and proposed by Beaufort Lagoon Ecosystem LTER, which includes the Kaktovik and Jago Lagoons.
        i. Benthic and water column biota assessments; microbes; fish surveys; community subsistence catch sampling.
6. Coastal water quality and chemistry:
    a. Studies conducted, underway and proposed by Beaufort Lagoon Ecosystem LTER, which includes the Kaktovik and Jago Lagoons.
        i. Samples will be collected during ~2 week field campaigns during (a) the ice-covered period in April, (b) during and immediately following ice break-up in June, and (c) during the open-water period in July/August. The season-specific data from these field campaigns will be complemented by continuous data streams for select parameters measured with sensors.
        ii. Sampling: Water biogeochemistry: Seasonal Alkalinity, NO3, NH4, DOC, DON, CDOM, POC, PON, stable isotopes, fatty acids, Chl. (HPLC)
        iii. In-situ sensors (moorings), Continuous monitoring of pH, temperature, salinity, water level (wave height and sea level), velocity.
        iv. In-situ sensors (discreet) Seasonal pCO2, temperature, salinity, O2, pH, PAR, Chlorophyll (chl), NEP/GPP/R, velocity

What are key information gaps?

1. Sea ice dynamics

2. Coastal erosion: We need updated shoreline erosion/change rates. Sandia National Laboratories and partners have proposed developing a predictive model of thermos-abrasive erosion for the permafrost Arctic coastline, which will complement efforts by the Beaufort Lagoon Ecosystems LTER (See sec 4. Coastal Habitats) and BOEM's Wave and Hydrodynamic Modeling in the Beaufort Sea (Stefansson Sound). USGS will conduct research on shoreline change in 2018 to understand coastal bluff and beach change.
    a. Overview presentation available at: https://www.iarpccollaborations.org/members/documents/10925?utm_medium=email&utm_source=transactional&utm_campaign=Weekly
    b. BOEM's Wave and Hydrodynamic Modeling in the Beaufort Sea is calibrated for Stefansson Sound, but will be informative along the broader coastline https://www.boem.gov/po-ak-17-01/

3. Coastal & Barrier Island geomorphology:
    a. Need more information on substrates, including ice content/permafrost, sediment composition, grainsize, etc.
    b. Recent observations of brown tundra along coast suggest salt-kill of tundra due to inundation; sometimes recovers when apparently associated with storm surges, but some areas have not recovered since 19070's suggesting subsidence. GPS instrumented monuments across area coast would provide information on changes in elevation, and this could be a component of the BLE LTER monuments if not already.
    c. Given the importance of barrier islands in protecting the erodible coast, a better understanding of barrier islands is needed to understand how they will change in a warmer, ice-free environment. Some have a thick tundra core, others may be entirely sediments; process is that they roll inland and are dynamic at a decadal scale now, but how will that change with altered runoff and increased storms?
4. Coastal bathymetry This information is needed to understand seafloor, gravel deposits and identify habitat for coastal species out to about 20m water depth.
5. Coastal habitats: Although it will take several years to assemble the baseline, the BLE LTER will make significant contributions to this topic. Study of Fish of nearshore Beaufort Sea planned by USGS in 2018.
6. Coastal water quality and chemistry: Need water quality and sedimentation baselines to understand changes associated with development; much of this baseline information will be collected as part of the new Beaufort Sea LTER

What studies/surveys need to be conducted to fill those information gaps? If possible, please include duration (start and end), staffing and cost estimates.

A significant number of studies are underway by USGS, BOEM and the National Science Foundation (NSF) funded Beaufort Sea Lagoons Long Term Ecological Research project. Continued funding support of the personnel and research for these projects is important.

1. Sea Ice Dynamics
2. Coastal erosion
3. Coastal & Barrier Island Geomorphology
4. Coastal bathymetry
5. Coastal habitats
6. Coastal water quality and chemistry

REPORTING TEMPLATE: Contaminants in Resources Other Than Air

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What do we need to know and why regarding subjects?

- *Legal, policy and management basis*:
  - ANILCA: Continued use of subsistence resources, and quality and quantity of water resources
  - Arctic National Wildlife Refuge Comprehensive Conservation Plan (CCP)
  - National Environmental Policy Act (NEPA)
  - Clean Water Act (CWA)
  - Endangered Species Act (ESA)
  - Marine Mammal Protection Act (MMPA)

- *Contaminants of concern* associated with oil and gas exploration and development (air emissions addressed elsewhere) include:

  - Heavy metals (cadmium, chromium, lead, mercury, nickel)
  - Salts
  - Naturally occurring radioactive materials (NORMS)
  - Components of dissolved and dispersed oil: Benzene-Toluene-Ethylbenzene-Xylene (BTEX), phenols, aliphatic and aromatic hydrocarbons (e.g., polycyclic aromatic hydrocarbons or PAHs), carboxylic acid, other volatile and semi-volatile organics
  - Many other industrially produced chemicals associated with equipment and camp maintenance, and oil and gas operations (e.g., batteries, compressors, heaters/separators)
  - Chemicals that are of concern to human health and safety, including:
    - arsenic, heavy metals, hydrochloric and sulfuric acids, hydrogen sulfide gas, BTEX, 1,1,1-trichloroethane, 1,2 - dichloroethane, chloroform,
    - cyclohexanone, methyl ethyl ketone, methyl isobutyl ketone

    - Sources of these include large and small spills, injection wells (saltwater disposal, other waste disposal, hydraulic fracturing), drilling muds (may include diesel, oils, detergents), drill cuttings, oily waste pits, other waste fluids such as produced water, hydraulic fracturing fluids, solid waste such as clays, precipitates, minerals, and suspended solids, landfill leachate, sewage lagoons, POL (Petroleum, Oil and Lubricants), dust, small spills from equipment failures (well casings, truck transport, pipe and tank corrosion, fittings failure), and abandoned equipment such as batteries, storage tanks, and electrical equipment.

- *Sensitive resources***:**
    - Aquatic habitats: rivers, lakes, groundwater, springs
    - Terrestrial habitats: soil, vegetation
    - Species groups:
        - Birds (from generally lowest to highest trophic level; higher trophic levels tend to accumulate higher contaminant concentrations):
            - Waterfowl (ducks, geese, seaducks) - important subsistence resource, including spectacled eiders which are listed under the ESA
            - Shorebirds - 1002 area is breeding area of international importance
            - raptors - some raptors on the North Slope already have elevated mercury concentrations
        - Fish - freshwater, anadromous fish are used for subsistence
        - Caribou - used for subsistence:
        - Polar bears - listed under the ESA and the MMPA
    - Fish, wildlife, and vegetation used for subsistence

What information is currently available to address the information needs for subjects?

- In the late 1980's, "baseline" data were captured in a scientifically and statistically sound manner (Contaminant Baseline Studies of the Arctic Coastal Plain 1002 Area and Adjacent Lagoons, Arctic National Wildlife Refuge, Alaska, 1988 - 1989). However, these data are too old to be used as pre-operational, or current baseline, data.

- There are contemporary data directly from the 1002 area on mercury in shorebirds (Perkins et al. 2016); trace elements in common eiders (Miller et al. in prep); and certain contaminants in polar bears (USGS unpubl. data). There are other data from across Arctic Alaska that may provide transferable information. All data would have to be evaluated for use as baseline data for oil and gas exploration and drilling.

What are key information gaps?

- Lack of contemporary contaminant concentrations in almost all sensitive resources that would serve as baseline data for NEPA, oil spill planning, and NRDAR.

- Complete project description, including timetable.

- Description of potential hazards to humans (including subsistence users) and the environment. These should be addressed in the NEPA process for all phases, but will need to be reviewed by the U.S. Fish and Wildlife Service.

- Disposal methods for all waste, including sewage, produced water and drilling muds. These should be addressed in the NEPA process for all phases, but will need to be reviewed by the U.S. Fish and Wildlife Service.

- Monitoring plans, including pre-operation baseline, for contaminants of concern and sensitive resources. These should be addressed in the NEPA process for all phases, but will need to be reviewed by the U.S. Fish and Wildlife Service.

- Full disclosure, characterization, and tracking of hazardous materials, including potential proprietary mixtures, which may be disposed of in the 1002 area, including by injection, to protect groundwater and springs. This may not be entirely addressed during the NEPA process, especially if proprietary information is involved.

What studies/surveys need to be conducted to fill those information gaps?

- The U.S. Fish and Wildlife Service does not currently have sufficient FTEs with environmental contaminants knowledge and skills to conduct or review studies, or evaluate NEPA documents, for oil and gas exploration or drilling in the 1002 area.

- Develop statistically sound contaminant monitoring program with enough power to detect biologically significant changes in contaminants concentrations, and changes in contaminants concentrations that may exceed regulatory thresholds. Include:

    - Evaluate sampling locations and matrices from previous contaminants baseline study for sufficiency as monitoring sites and matrices, and evaluate current data for suitability as baseline data.

    - Add site-specific monitoring sites and matrices depending upon project description to provide baseline (pre-project) data.

    - For groundwater monitoring, include location, depth, and monitoring interval of groundwater wells that would identify changes from baseline specifically for springs.

- Hydrological evaluation of underground aquifers and surface waters, including springs, in the 1002 area to avoid and minimize contaminant migration potential.

- Updated baseline sampling in fish, especially those used for subsistence, of contaminants associated with oil and gas development including heavy metals, persistent organics, NORMs, and hydrocarbons.

- Updated baseline contaminant exposure information for birds breeding in the 1002 area, and those using deltas and lagoons for fall staging, with particular emphasis on hydrocarbon and heavy metal exposure, and how contaminant burdens may affect subsistence value.

- Continued collection of polar bear contaminants exposure data, with an emphasis on hydrocarbon and heavy metal exposure.

REPORTING TEMPLATE

Discipline/Subject Area: Cultural Resources

Lead facilitator: Edward J. DeCleva, Regional Historic Preservation Officer, U.S. Fish and Wildlife Service, 1011 East Tudor Road, MS-235, Anchorage, AK 99503. Telephone: (907) 786-3399. Email: edward_decleva@fws.gov.

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Sarah Meitl, Review and Compliance Coordinator, State of Alaska Office of History and Archaeology. (907) 269-8720.

Hollis Twitchell, Assistant Manager, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge. (907) 456-0512.

What do we need to know and why regarding subjects?

Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of its actions (in this case permitting oil and gas exploration and extraction) on historic properties (defined as prehistoric and historic objects, features, structures, sites, and districts).

In order to consider effects, we will need to know the nature, extent and locations of historic properties (hereinafter, cultural resources) and evaluate these alongside specific oil and gas exploration and operations proposals.

Recorded cultural resource sites consist of consist of prehistoric and historic features (eg., drying racks and graves), structures, tent rings and artifact scatters.

Threats to cultural resources include disturbances caused directly by seismic testing, installation of ice roads, support facilities and drill pads.

Mitigation measures are consideration of avoidance, minimization, and data recording (via archaeological excavation).

What information is currently available to address the information needs for subjects?

Previous cultural resource investigations in the Arctic Plain 1002 area are limited to the coast, some waterways and the northern foothills of the Brooks Range. Key sources include:

Grover, Margan A. and Erin Laughlin
2012 Archaeological Survey of the Mid-Beaufort Sea Coast: An Examination of the Impacts of Coastal Changes on Cultural Resources.

Hall, Edwin. S., Jr. and David Libbey
1982 Preliminary Archaeological and Historic Resource Reconnaissance of the Coastal Plain Area of the Arctic National Wildlife Refuge, Alaska.

Generally, these concentrated on limited aerial and pedestrian reconnaissance surveys of areas modeled to likely have high potential to contain archaeological resources. Collectively, the surveys identified several prehistoric to early historic period seasonal occupation sites consisting of:

a. Structures and features such as log cabins, sod houses, graves, ice cellars, and drying racks. Most occur adjacent to Beaufort Sea coast, although a few have been found on river courses several miles inland.

b. Tent ring complexes generally located on well-drained river banks, terraces, ridge lines and hill/bluff tops that provide extensive views across the surrounding landscape.

c. Lithic artifact scatters, not associated with features or structures, located adjacent to watercourses.

What are key information gaps?

Previous cultural resource inventories and investigations in the Arctic Plain 1002 area have been limited to theoretically predicted high potential areas along the coast and some watercourse segments. We do not know the extent of cultural resource sites across the landscape.

What studies/surveys need to be conducted to fill those information gaps?

Cultural resource investigations will be necessary to sufficiently identify cultural resource sites, determine the significance of such sites, to evaluate effects to sites determined eligible under National Register of Historic Places criteria, and to determine avoidance, minimization and mitigation standards for eligible sites that would be adversely affected by oil and gas activities.

USFWS should commit one full-time GS-0193-11 archeologist to oversee agency cultural resource investigation permitting and Section 106 responsibilities during the duration of oil and gas exploration and extraction operations development.

Subject Area: Fishes

Lead facilitator: Randy Brown, U.S. Fish and Wildlife Service, <randy_j_brown@fws.gov>, (907 456-0295

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What do we need to know about fishes and why:

Water is essential fish habitat. Water is also a critical component in virtually all stages of the industrial process of hydrocarbon development. Potential sources of water for industrial use along Alaska's North Slope include rivers, lakes, snow, and ice; perhaps even desalinated marine sources. Fish depend on the aquatic environments of nearly all rivers, many lakes, and the near-shore marine areas in or adjacent to the 1002 Area. Surplus water, water that is present in rivers and lakes and in the form of snow and ice, that is not required to sustain fish populations, would conceivably be available for industrial use. If our goal is minimizing the impact of industrial development on fishes that live in or migrate through the 1002 Area we must identify water that is required to sustain them and preserve that water for fish use.

In addition to direct industrial use of water, seismic activity during the exploratory phase of hydrocarbon development has the potential to impact fishes as well. In recent years winter seismic surveys most commonly use a truck-based technology called Vibroseis to generate the acoustical energy pulses necessary to locate subsurface geological formations that might contain oil or gas. Vibroseis is much less harmful to fishes than explosive charges that were commonly used in the past. These downward directed pulses of acoustic energy create pressure waves into the ground or through ice into lakes and rivers below. They are known to influence the behavior of fish in the vicinity of the energy source, although experimental data suggest it does not cause the physical damage typical of explosives.

What information is currently available to address the information needs for fishes:

The eastern North Slope in Alaska is endowed with limited freshwater options for fish. As a result, there are only a few species that occupy the freshwater habitats that are available. Lake density is very low east of the Canning River drainage but increases progressively to the west. Several mountain streams cross the coastal plain between the Canning River and the Canadian border. These streams flow during summer with snowmelt, rainfall, perennial springs, and for some streams, melting glaciers, however, only the perennial springs provide flow during winter reducing habitable environments for fishes to about 5% of what is available during summer.

The nearshore environment in the southern Beaufort Sea, adjacent to the coastal plain of the eastern North Slope in Alaska, is a mix of open coast and lagoons bounded by barrier islands. In summer, water along the coast becomes brackish and relatively warm because of flow from the Mackenzie River and other rivers along the eastern Arctic coastline. The lagoons are relatively shallow, the amplitude of the tides is very small (≤30 cm), barrier islands restrict flow to some extent, and the environment becomes much less salty and much warmer than sea water outside the barrier islands. The lagoons are very productive foraging environments for marine and anadromous species during summer. In winter, in part because of reduced flow between lagoons and the sea, and in part because of ion exclusion during ice formation, lagoons become hypersaline environments that get even colder than normal sea water under ice. As winter approaches and the lagoons begin freezing up, anadromous fishes return to freshwater environments and marine fishes retreat to adjacent marine habitats.

Freshwater species present in the eastern North Slope of Alaska include lake trout *Salvelinus namaycush*, Arctic char *S. alpinus*, Dolly Varden *S. malma*, Arctic grayling *Thymallus arcticus*, round whitefish *Prosopium cylindraceum*, burbot *Lota lota*, ninespine stickleback *Pungitius pungitius*, and slimy sculpin *Cottus cognatus*. Slimy sculpin are known to occur only in drainages west of the Canning River. Round whitefish and burbot are present in the Canning River and large drainages farther west but not east of the Canning River. Lake trout and Arctic char are found only in certain lakes. Dolly Varden is present in three life history forms: anadromous populations in which most members rear in freshwater rivers for 2–4 years then begin migrating to sea to feed each summer; residual dwarf males of the anadromous populations that choose to stay in freshwater rivers rather than migrate to sea; and dwarf resident populations that exist in perennial springs and isolated lakes. Arctic grayling occur in some lakes and also in rivers with perennial springs that are used for overwintering habitat. Ninespine stickleback occur as both freshwater residents and as anadromous forms. They are common in lakes within the coastal plain and the lower reaches of many rivers throughout the eastern North Slope.

Anadromous species known to occur in or adjacent to the eastern North Slope of Alaska include Dolly Varden, ninespine stickleback, Arctic cisco *Coregonus autumnalis*, broad whitefish *C. nasus*, humpback whitefish *C. clupeaformis*, least cisco *C. sardinella*, chum salmon *Oncorhynchus keta*, pink salmon *O. gorbuscha*, Chinook salmon *O. tshawytscha*, and rainbow smelt *Osmerus mordax*. Dolly Varden and ninespine stickleback are the only anadromous species in this group that maintain populations within the rivers of the eastern North Slope. Dolly Varden are known to migrate long distances along the coast during their summer feeding forays, east to the Mackenzie River and west to the Colville River or beyond, and some individuals migrate into offshore waters as well. Ninespine

stickleback appear to be much more localized in nearshore environments. Arctic cisco have natal origins in the Mackenzie River to the east but disperse as juveniles to coastal habitats farther west including the Colville River delta, where many overwinter in brackish environments. Rearing Arctic cisco make annual feeding migrations along shore during summer and eventually return to the Mackenzie River to spawn. Broad whitefish, humpback whitefish, and least cisco that are encountered in nearshore environments in the eastern Arctic have natal origins in either the Mackenzie River to the east or the Sagavanirktok or Colville rivers to the west. Salmon species that occur in the eastern Arctic are thought to be strays from southern Chukchi or northern Bering Sea populations, although some believe that self-sustaining chum salmon populations may exist in the Mackenzie River drainage somewhere. Rainbow smelt are known to spawn in the Mackenzie and Colville rivers as well as in the Kuk River drainage farther west. Dolly Varden and Arctic cisco are the primary food fishes for people in north east Alaska.

There are about 12 species of marine fishes that are commonly encountered in nearshore brackish environments, only four of which are relatively abundant during the summer season. These are fourhorn sculpin *Myoxocephalus quadricornis*, Arctic flounder *Pleuronectes glacialis*, saffron cod *Eleginus gracilis*, and Arctic cod *Boreogadus saida*. While anadromous species tend to migrate along shore in the southern Beaufort Sea, marine species are thought to follow a very different pattern; moving towards shore and into shallow water during summer and away from shore and into deeper water during winter. It is not uncommon to find these four common marine species in brackish environments during summer, or even in the very lower reaches of the rivers in the area.

What are the key information gaps:

We currently have a good understanding of fish species present in or near the 1002 Area, as well as the types of aquatic habitats they use. We have some information on species presence in specific lakes, streams, and near-shore habitats. We don't have this information for all aquatic habitats that might be considered for exploratory seismic surveys or industrial water use. This information will be important prior to permitting for these activities.

We do not have a good understanding of the consequences of harvesting aufeis from perennial springs on flow levels downstream the next summer. Will it be adequate to support fish migration or not? This information will be important prior to permitting the use of aufeis.

What studies or surveys need to be conducted to fill those information gaps:

REPORTING TEMPLATE: Oil Spills

Lead facilitator:
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What do we need to know and why regarding subjects?

- *Legal, policy and management basis* for oil (and other hazardous materials) spill planning, response, and restoration include:
    - Oil Pollution Act (OPA), including Natural Resource Damage Assessment and Restoration (NRDAR)
    - Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
    - National Contingency Plan (NCP)
    - Endangered Species Act (ESA)
    - Marine Mammal Protection Act (MMPA)
    - National Environmental Policy Act (NEPA)
    - U.S. Department of the Interior and U.S. Fish and Wildlife Service (Service) policies

- *Concerns* associated with oil (and other hazardous materials) spills in the event of oil and gas exploration and development include:
    - Exposure of sensitive resources to dissolved and dispersed oil, including Benzene-Toluene-Ethylbenzene-Xylene (BTEX), phenols, aliphatic and aromatic hydrocarbons (e.g., polycyclic aromatic hydrocarbons or PAHs), carboxylic acid, other volatile and semi-volatile organics and potentially, heavy metals, and their effects on biota managed by the Service. Also, adverse perturbations in the ecosystem upon which Service trust resources rely due to exposure of any ecosystem component to these substances.

    - Exposure and recovery of sensitive resources to response activities (e.g., use of heavy equipment, trenching and digging, use of dispersants or *in-situ* burns, etc.).

    - The effect of any interaction between climate change and adverse exposure to oil or other hazardous substances on the fitness of Service trust resources on the individual and population levels.

    - Lack of logistic capacity to respond to spills in the 1002 area, and limited capacity elsewhere on the North Slope.

- *Sensitive resources*:

- Aquatic habitats: shorelines, near-shore marine waters and lagoons, rivers, lakes, groundwater, springs

- Terrestrial habitats: soil, vegetation

- Species groups:
  - Birds (seabirds, waterfowl, shorebirds, raptors), including eiders listed under the ESA
  - Fish (freshwater and anadromous)
  - Polar bears - listed under the ESA and the MMPA
  - Terrestrial mammals, including caribou, muskox, grizzly bears, and small mammals that have important roles in the Arctic ecosystem food web

- Fish, wildlife, and vegetation used for subsistence

What information is currently available to address the information needs for subjects?

- In the late 1980s, "baseline" data on environmental contaminants were captured in a scientifically and statistically sound manner (Contaminant Baseline Studies of the Arctic Coastal Plain 1002 Area and Adjacent Lagoons, Arctic National Wildlife Refuge, Alaska, 1988 - 1989). However, these data are too old to be used as pre-assessment data for spill response (resources at risk) and NRDAR purposes.

- National and statewide oil spill planning tools exist and can be updated (e.g., shoreline Environmental Sensitivity Index (ESI) maps; NOAA's Arctic Environmental Response Management Application (ERMA): https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma/arctic-erma.html). These tools inform oil spill planning and response; however, they are generally focused on coastal and marine habitats. Tools for the 1002 area, especially inland, may need updating.

What are key information gaps?

- NRDA pre-assessment data identified as "information gaps" under other Reporting Templates. These include biological and other trust resource survey data. For example, date-specific locations, species, numbers, and habitat-based activities (e.g., breeding, staging) of waterfowl and shorebirds. If breeding in the Arctic, quantitative information on reproductive success. These data would also help inform contingency planning and spill response activities, including identification of resources at risk.

- Oil spill response plans and contingency plans, based on seismic project applications and NEPA project descriptions.

- Full disclosure, characterization, and tracking of hazardous materials, including potential proprietary mixtures, for spill planning purposes. Including ecological toxicity data for both components and mixtures of hazardous substances.

What studies/surveys need to be conducted to fill those information gaps?

- Identify shoreline segments for Shoreline Classification and Assessment Techniques (a spill response technique used when assessing the degree of oiling).

- Evaluate data layers in Arctic ERMA and other oil spill planning tools to determine suitability for adequate spill response relative to proposed activities. Inland areas are especially data poor.

- Evaluate project-specific oil spill response plans, focusing on how fish and wildlife resources are addressed.

- NRDA pre-assessment data needs to be enumerated in other Reporting Templates.

- Area-specific surveys of wildlife presence, numbers, and reproductive success, addressing all times of the year.

- Toxicity testing on wildlife.

REPORTING TEMPLATE

- **Discipline/Subject Area: Terrestrial mammals other than caribou**

- **Lead facilitator:** Stephen M. Arthur, U.S. Fish and Wildlife Service, stephen_arthur@fws.gov, 907-455-1830.
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- **What do we need to know and why regarding subjects?**

The purposes of the Arctic National Wildlife Refuge, as established by the Alaska National Interest Lands Conservation Act include:

- to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, …, grizzly bears, muskox, Dall sheep, wolves, [and] wolverines, …;
- to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents,

Conservation of the mammals in the Arctic National Wildlife Refuge in association with the exploration, development, and production of oil and gas resources on the coastal plain will require information regarding:

- Importance of the 1002 Area relative to distribution, abundance, reproduction, and habitat requirements of mammal species;
- Likelihood and consequences of disturbance or displacement of mammals from the 1002 Area (or portions thereof) due to exploration and development of petroleum resources;
- Potential impacts of development on access to the area by subsistence hunters and trappers, and on viewing opportunities of other Refuge visitors;

Major mammal species or species groups of concern include:

Carnivores

- Documenting the location of grizzly bear dens near areas of on-going human activities is needed on an annual basis to avoid disturbing bears and to reduce potential human-bear conflicts. Seasonal diets of bears should be evaluated,

and effects of supplemental food (primarily garbage) on bear distribution, behavior, and rates of reproduction and growth, and the frequency of human-bear conflicts need to be monitored. Periodic density estimates for grizzly bears in the 1002 area and the neighboring foothills will be needed to assess long-term population-level effects on bears and resulting effects on prey species.

- Studies of effects of human activities, including provision of supplemental food and construction of roads and pipelines, on populations and distributions of red and arctic foxes are needed to assess potential effects on both foxes and their prey (ground-nesting birds and rodents). Competitive relationships between fox species also need to be monitored.

- Little is known about wolf and wolverine densities and relationships with infrastructure on the North Slope. Surveys are needed to document wolf and wolverine abundance and distribution and to identify den sites.

Herbivores

- Changes in moose distribution and abundance are likely to occur as a result of shrub expansion on the coastal plain, and potential effects of winter snow conditions should be monitored to understand changes in moose populations and availability of moose for subsistence hunters.

- Information is needed to assess the major factors limiting distribution and abundance of moose and muskox (e.g., forage quality and abundance, weather, predation, disease).

- Abundance and density of muskoxen within the Arctic Refuge should be monitored to determine if muskoxen return to the Refuge from adjacent areas and if this is influenced by oil field infrastructure or changes in abundance and distribution of predators and other prey species.

- Distribution, abundance, and habitat associations of arctic ground squirrels should be documented. Ground squirrels are a key species in the Arctic, in that they are an important prey for many predators and can influence vegetation communities by consuming vegetation and by fertilizing the tundra around their colonies. Thus, changes in ground squirrel populations can have profound effects on local communities.

- Population levels of microtines and other small rodents should be monitored to determine the timing and magnitude of population highs and lows and how these relate to other components in the ecosystem, especially population dynamics of mesocarnivores and their alternate prey (ground-nesting birds). Effects of climate

change on the distribution and dynamics of small mammals should also be investigated.

- Small mammal species (rodents and shrews) on the coastal plain should be inventoried; particularly species for which little is known, such as the holarctic least shrew. Very little data are currently available concerning which small mammal species occur on the coastal plain, or their population status.

- The distribution and abundance of hares on the coastal plain should be documented, and species identity should be determined (snowshoe vs. Arctic hare). Hares are a key species of the boreal forest, and are likely to increase their range northward as the climate warms. This will have far-reaching effects on both vegetation and other mammals and birds.

➢ **What information is currently available to address the information needs for subjects?**

Surveys of the abundance and distribution of several mammal species were conducted during the Arctic National Wildlife Refuge Coastal Plain Resource Assessment studies of the 1980s. These included studies of muskoxen, moose, Dall's sheep, wolves, arctic foxes, wolverines, grizzly bears, arctic ground squirrels, and other rodents. Much of this information was limited to documenting the occurrence and, in some cases, estimates of abundance of these species. Since 1987, some additional surveys have been conducted to monitor abundance and distribution of muskoxen, moose, and Dall's sheep and to collect demographic data on some of these. Small mammal species occurrence along the Canning River and a few other locations has been documented.

- Grizzly bear use of the 1002 Area varies seasonally. Bear abundance is greatest during early summer; bear density in the area at this time was estimated at 1 bear per 30 square mi (78 square km). Most bears that use the coastal plain move into the foothills for denning, but approximately 5% of grizzly bears den on the coastal plain. Bears commonly prey on caribou, moose, muskoxen, ground squirrels, and small rodents, as well as berries and other vegetation. Across northern North America there is evidence of increasing abundance of grizzly bears along the arctic coast; however, no data are available to determine if this has occurred in the Arctic Refuge. Denning bears are susceptible to disturbance from human activities during winter (particularly seismic exploration). Disturbance may cause bears to abandon their dens and suffer increased rates of mortality. This risk is especially high for newborn bear cubs.
- Arctic foxes are widespread and relatively common near the arctic coast during summer. Red foxes are fairly common inland, and may be increasing in abundance along the coast. Where both species occur, red foxes have been

observed killing arctic foxes. Sudies in Scandinavia suggest that red foxes may outcompete arctic foxes and may be the cause of declining arctic fox populations in some areas. The principal prey of both species during summer includes a variety of small mammals and ground nesting birds, but particularly brown and collared lemmings. Lemming populations in the Arctic cycle in abundance, with large peaks in abundance occurring approximately every 4 years, and arctic fox abundance generally cycles in response to changes in lemming abundance. There is evidence from Scandinavia that the magnitudes of these cycles have been reduced in recent years in association with a warming climate. Reduction or elimination of fox population cycles is predicted to have negative effects on alternate prey species, such as ground-nesting birds. In addition, provision of supplemental food, such as garbage, is likely to increase fox abundance near industrial infrastructure, and this may reduce survival of some ground nesting bird species. On the Alaskan North Slope, arctic foxes have a high incidence of rabies, but little is known about the relationship between disease and fox population dynamics or the potential for rabies to spread to other species.

- Wolves and wolverines are present but not abundant on the Arctic coastal plain. During the 1002 resource assessment studies of the 1980s, the locations of several wolf dens were documented. However, little is known about current wolf or wolverine abundance and distribution in the Arctic Refuge.
- Moose densities are generally low on the Refuge's coastal plain in winter, but some moose that spend the winter along drainages in the mountains use the 1002 area in summer. Survey data suggest that moose numbers along these drainages declined during the late 1980s and remained low through approximately 2010. More recent surveys suggest a moderate increase in moose abundance has occurred in areas to the east and west of the 1002 area, but little change is evident within this area.
- Muskox abundance in the Arctic Refuge peaked at approximately 300 during the mid 1990s, then declined to near zero by 2006. Since then, small groups of muskoxen have been found occasionally within the Refuge during summer; these most likely are animals that live primarily east of the Refuge in Canada or on Alaska state land west of the Canning River. The population decline was likely due to a combination of predation and other factors, including winter weather, disease, and changes in distribution of other ungulates.
- Dall's sheep do not occur in the 1002 Area but are found in the Brooks Range Mountains to the south, where the species reaches its northernmost geographic extent. The eastern Sadlerochit Mountains, near the southern border of the 1002 Area, contains habitat suitable for sheep, and the species has occasionally been seen there. Sheep are sensitive to disturbance from noise and aircraft traffic, particularly during the lambing season (mid to late May). Dall's sheep populations throughout the Brooks Range peaked during the 1980s, declined steeply during the early 1990s (most likely due to adverse weather), increased slowly through approximately 2011, then declined again during 2012-2014 in association with a

series of severe winters. Surveys during 2015-2017 suggested that lamb production and survival were relatively high, and the population may once again be increasing.

- Ground squirrels have a patchy distribution in the 1002 Area because denning habitat is limited by a lack of well drained soils. In areas where ground squirrels occur, they are an important source of food for foxes, bears, wolves, wolverines and weasels.
- Microtine rodents, particularly brown lemmings, are year-round residents of the 1002 Area and are an important source of food for many species including bears, wolves, foxes, and wolverines in years when they are abundant. Extreme fluctuations in population abundance affect the abundance and distribution of lemming predators as well as predation on other species such as ground nesting birds.
- Hares have been documented in the mountains of the Brooks Range and on the arctic coastal plain further west. Presumably these are snowshoe hares from more southern distributions, but they also may be arctic hares coming from Canada. Hares are a valuable resource for predators in areas where they are abundant. Hare populations can increase quickly and can affect local vegetation communities, with cascading effects on other herbivores. The presence of hares could increase the presence of lynx, a species that has been observed in the 1002 area in past years.

➢ **What are key information gaps?**

- We need a greater understanding of predator/prey and competitive relationships among red and arctic foxes, lemmings, and ground-nesting birds; how these are affected by lemming cycles; and how these complex relationships may be altered by a warming climate and anthropogenic disturbance.
- We lack current data regarding the abundance and distribution of grizzly bears; the relative importance of the 1002 area as denning habitat is unknown; improved methods are needed to reduce availability of anthropogenic foods and the resulting negative interactions with human activities.
- Current data are needed regarding the distribution and abundance of wolves and wolverines; to document den site locations and habitat attributes; evaluate potential for disturbance or mortality related to interaction with human activities; and evaluate effects of increased access by subsistence hunters and trappers.
- More information is needed regarding how predation, weather, disease, and nutrition influence population dynamics of moose and muskoxen; the potential for reestablishment of muskoxen in the Refuge by expansion of neighboring populations; and the potential effects of human activities (positive: protection from predators; or negative: disturbance or displacement) on both species.

- Are lemming cycles changing? How does this affect survival and population dynamics of ground-nesting birds? Does this moderate or increase effects of human activities?
- We have only limited knowledge of which mammal species are present on the coastal plain; information is particularly needed for little-known species and those whose ranges are restricted to arctic tundra.

➢ **What studies/surveys need to be conducted to fill those information gaps?**

Exploration phase:

- Develop methods to estimate abundance of fox and lemming populations; monitor changes over time; and assess impacts on nesting birds. Estimated cost: $70,000 annually for 3 years to develop and verify techniques. This information will be needed to distinguish between natural influences and potential effects of future development, and to assist with the design and siting of future infrastructure.
- Estimate abundance of grizzly bears in the 1002 Area during June. Estimated cost: $100,000 during one year, or $50,000 per year for 2 years. This baseline information will be needed to assess potential effects of future development.
- Continue annual surveys for moose and muskoxen that systematically cover the 1002 area. Parameters should include abundance, distribution, sex and age structure, reproduction and survival. Estimated cost: $10,000-$20,000 per year. These ongoing surveys are needed to assess responses of these species to human activities and habitat changes.
- Investigate factors limiting distribution and abundance of muskoxen on the eastern North Slope. Collaboration with Alaska Dept. of Fish and Game and Yukon Dept. of Environment. Potential cost: $100,000 annually for 5 years; cost sharing to be determined. Expansion of muskoxen back into the Arctic Refuge would greatly enhance the chances of survival for this small and fragmented population. These data are needed to evaluate potential effects (both positive and negative) of development and operation of oil field infrastructure.
- Investigate the relationship between climate change, vegetation, and moose population dynamics. Could be built into ongoing monitoring work; primary cost would be additional staff time for data analysis plus ~$10,000 per year for browse surveys. These data are needed to differentiate between natural and anthropogenic effects on moose populations. Study should begin prior to development to provide baseline information on this population.
- Revisit wolf dens documented during the 1980s to see if any are still being used and identify any new den sites. Wolf observations during seasonal surveys for ungulates would provide some indication of wolf packs that occupy the 1002 area. Estimated cost: $10,000. Wolf dens are thought to be rare within the 1002

Area; however, any that are found should be flagged for special management consideration.

- Record observations of wolverines and their tracks during late winter surveys for ungulates to obtain information on relative abundance and distribution. Potential denning habitats of wolverines with kits should be mapped using satellite imagery or other methods. (No cost other than staff time, assuming ungulate surveys are funded). Surveys should begin prior to development to provide baseline information.
- Conduct an inventory of small mammal occurrence on the coastal plain. Estimated cost: $30,000 annually for one to 4 years. There is a critical need for baseline information prior to development of the coastal plain. This information will be needed to guide the design and siting of future infrastructure.
- Map the distribution of potential ground-squirrel habitat. This may be possible from satellite imagery based on local vegetation or in combination with broad-scale vegetation or soils mapping efforts. (No cost other than staff time). This information will be needed to guide the design and siting of future infrastructure.

Development and production phase:

- Conduct long-term monitoring of relative abundance of foxes and lemmings, and their effects on nesting birds; Estimated cost: $20,000 annually, in collaboration with shorebird and waterfowl monitoring. These data are needed to distinguish between natural and anthropogenic effects.
- Monitor occurrence and behavior of grizzly bears in relation to human activities; identify locations of dens; estimate population size at 5-year intervals. Estimated cost: $30,000 per year plus $100,000 every 5 years. This information is needed to monitor effectiveness of established mitigation measures and to ensure human safety.
- Continue annual surveys for moose and muskoxen that systematically cover the 1002 area in late winter. Estimated cost: $10,000 per year. These ongoing surveys are needed to assess responses of these species to human activities and habitat changes.
- Continue investigation of the relationship between climate change, vegetation, and moose population dynamics. Could be built into ongoing monitoring work; primary cost would be additional staff time for data analysis plus ~$10,000 per year for browse surveys. These data are needed to differentiate between natural and anthropogenic effects on moose populations.
- Develop protocols for long-term monitoring of habitat characteristics important to large herbivores, including vegetation type, nutrient quality, snow characteristics (depth, density, extent, phenology, icing events). Initial costs would be limited to additional staff time; future costs to be determined. This information will be needed to assess long-term impacts of development and to distinguish those from effects of natural processes.

- Record observations of wolves and wolverines and their tracks during seasonal surveys for ungulates to obtain information on relative abundance and distribution. An inventory of known dens should be established. (No cost other than staff time, assuming ungulate surveys are funded). This information will be used to guide design and siting of future infrastructure.
- Monitor observations of hares and their tracks to detect potential range expansion; determine species identity of hares that are observed. (No cost except staff time to compile and verify observations).

REPORTING TEMPLATE

Discipline/Subject Area: Paleontological Resources

Lead facilitator: Edward J. DeCleva, Regional Historic Preservation Officer, U.S. Fish and Wildlife Service, 1011 East Tudor Road, MS-235, Anchorage, AK 99503. Telephone: (907) 786-3399. Email: edward_decleva@fws.gov.

Individuals contacted:

Patrick S. Druckenmiller, Ph.D., Associate Professor of Geology, University of Alaska Fairbanks, (907) 474-6954.

Brent Breithaupt, Geologist (Paleontology), Bureau of Land Management, (307) 775-6052.

Robert King, State Archaeologist, Bureau of Land Management, Alaska State Office. (907) 271-5510.

What do we need to know and why regarding subjects?

The Paleontological Resources Preservation Act (PRPA) of 2009 requires the Secretary of the Interior to manage and protect paleontological resources on Federal lands using scientific principles and expertise.

The vast majority of the Arctic Plain 1002 has very little exposed geology, most of which is likely comprised of Quaternary Period deposits (personal communication with Patrick Druckenmiller). Therefore, any scientifically significant paleontological resources that may be present are most likely to be associated with Pleistocene Epoch remains, particularly mammoth, steppe bison, horse and other Ice Age mammal fossils.

The probability of scientifically significant paleontological resources older than the Quaternary Period being encountered and impacted by oil and gas exploration is low.

What information is currently available to address the information needs for subjects?

The University of Alaska Fairbanks, Department of Geology, is currently working with the Bureau of Land Management Alaska State Office to prepare a Potential Fossil Yield Classification document to identify the geologic time scale within the Arctic Plain 1002 area and to evaluate the potential for paleontological resources (p.c. with Patrick Druckenmiller).

What are key information gaps?

There have been no paleontological resource investigations conducted within the Arctic Plain 1002 area.

What studies/surveys need to be conducted to fill those information gaps?

Because USFWS has no expertise in the field of paleontology, it is recommended that the BLM paleontologist would need to advise on the subject and review any technical aspects of environmental review generated for oil and gas exploration and extraction.

Paleontological resource investigations, if any, can likely be conducted concurrent with cultural resource investigations to sufficiently identify Pleistocene Epoch paleontological resources that may be located at the surface to determine avoidance, minimization and mitigation standards.

USFWS may need to authorize and oversee paleontological research on the Arctic Plain 1002 in advance of or during oil and gas related project proposals. Responsibility for paleontological permitting lies partially with the USFWS Regional Historic Preservation Officer and can be accommodated with current regional cultural resources staffing.

Subject Area: Polar Bears

Lead (name and contact information): Dr. Patrick Lemons, Chief Marine Mammals Management, U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska 99516. Phone: 907-786-3668. Email: patrick_lemons@fws.gov

Individuals Contacted: Todd Atwood (USGS), George Durner (USGS), James Wilder (FWS), Christopher Putnam (FWS), Ryan Wilson (FWS), Michelle St. Martin (FWS), and Mary Colligan (FWS).

What do we need to know and why (i.e. what decisions or determinations are required)(please address what we know about resources in the area (distribution, abundance, seasonal movements), how they may be impacted by oil and gas development, mitigation measures available and their effectiveness, subsistence activities)?

> **MMPA:** We can specify the incidental, but not intentional, taking of **small numbers** of polar bears by harassment if we can find that such harassment will have a **negligible impact** on the stock of polar bears and will not have an unmitigable adverse impact on the **availability of polar bears for subsistence uses** (emphasis added).
>
> **ESA:** Under Section 7 of the ESA we will have to conduct consultations on federal action(s) and will have to make a determination as to whether such actions would **jeopardize** the continued existence of polar bears or **adversely modify or destroy** designated critical habitat (emphasis added).

What information is currently available to address the information needs identified above (include citations)?

Information needed to make the above determinations includes population dynamics of the Southern Beaufort Sea (SBS) subpopulation of polar bears, habitat and denning ecology of polar bears in the 1002 area, the subsistence and cultural use of the 1002 Area, and information on human-bear interactions that will accompany oil and gas development. We briefly describe the current state of that information relative to our determinations below.

- Population Dynamics
    - Information on the population size and trend of SBS polar bears suggests that the population experienced a 40% decline between 2001 and 2010. However, this information also suggested that the population may have stabilized by the end of that time period. Given the current information is now 8 years old, and the uncertainty surrounding the trend of the population at the end of the time period, reliance on this information for management decisions is problematic.

- Habitat Ecology
    - Our current understanding of polar bear habitat use and denning in the 1002 area is primarily based on satellite radio collared bears from the larger SBS subpopulation. However, because we are reliant on satellite radio collars applied primarily to the western portion of the SBS, and the number of collared bears that then use is only a subset of this larger sampling effort, we generally lack an understanding of the

importance of the 1002 Area to the overall population of SBS bears. Therefore, reliance on the current information is problematic.

- Subsistence and Cultural Use
    - The only study conducted that included information concerning subsistence use and the cultural importance of polar bears in the 1002 Area was published in 1997. The information provided in that study pertaining to the 1002 Area is limited. Updated and more detailed information will be necessary as part of our determinations outlined above.

- Human-Bear Interactions
    - Because the 1002 Area was managed as a wildlife refuge in the past, no significant industrial activity and related human-bear interactions have occurred there in the last 35 years. Importantly, given the uniqueness of the habitat in this area and the importance of the 1002 Area to polar bears, reliance on mitigation measures used in the NPR-A and Prudhoe Bay may not comprehensively address potential human-bear interactions in the 1002 Area.

What are key information gaps?

- Population Dynamics
    - An accurate and current understanding of the population dynamics of the Southern Beaufort Sea subpopulation of polar bears is needed in order to estimate the impact of anticipated take (i.e. to determine small numbers and make negligible impact determinations under MMPA and jeopardy determinations under ESA).

- Habitat Ecology
    - Understanding the relationship between polar bears and environmental parameters helps us explain current habitat use patterns and make future predictions on how distribution and movement is likely to respond to predicted sea ice loss and other habitat changes. This understanding is needed in order to predict how many and how animals are likely to be impacted by proposed activities (small numbers and negligible impact determination under MMPA) and whether proposed actions are likely to adversely modify or destroy designated critical habitat (ESA determination).

- Subsistence and Cultural Use of Polar Bears
    - An activity or suite of actions can affect the availability of polar bears for subsistence use by decreasing the overall number of animals or by changing their movements.
    - Understanding polar bear movements and current hunting practices helps us understand the current availability of polar bears for subsistence hunting and predict the potential impact of proposed actions on the availability of polar bears for subsistence use (MMPA determination).
    - Maintaining clear and consistence communications and relationships with communities concerning ongoing research and development activities.

- Human-Polar Bear Interactions

- Understanding the potential spatial and temporal overlap between polar bears and oil and gas development and the factors influencing the likelihood and consequences of interactions between polar bears and those development activities is essential to our ability to determine the number of polar bears likely to be taken (small numbers determination under MMPA) and the consequences of that take to the individual animal and ultimately the stock (negligible impact determination under MMPA) and to the species (jeopardy determination under ESA).
- Identification of possible methods to avoid overlap and interactions between polar bears and Industry activities, and to reduce the potential for interactions, are essential tools to facilitating our ability to achieve a small numbers determination and reach a negligible impact determination (MMPA) as well as avoid jeopardy and adverse modification or destruction of critical habitat (ESA).

What studies/surveys need to be conducted to fill those information gaps? Please include duration (start and end), lead, and cost estimates.

- Population Dynamics
  - Estimation of abundance and population dynamics (i.e. demographic rates such as survival and reproduction). Surveys using mark-recapture methods are a more viable option than other non-invasive techniques (e.g., aerial survey).
  - Continue to evaluate emerging technologies (e.g., high-resolution satellite imagery, GPS collar reliability, collar drop off mechanism performance) for integration into existing monitoring plans.

- Habitat Ecology
  - Improve our understanding of the environmental and biological characteristics of important polar bear habitats, with a particular focus on denning habitat.
    1. Continue, expand, and improve den detection, mapping, and monitoring activities. We see higher use of habitat within the 1002 area and greater reproductive success for land-based dens.
    2. Identify movement and land use patterns of polar bears in the 1002 area, and projected changes due to sea ice loss, especially given the increased proportion of the population coming on shore in that region. Identify potential for habitat use and behavioral patterns to be modified due to increased human activities.

- Assess Impacts to Subsistence and Cultural Use of Polar Bears
  - Periodically assess key community perspectives, values and needs regarding human-polar bear interactions and sustainable use of polar bears for subsistence purposes.

- Human-Polar Bear Interactions – Identify Current Methods and Develop New Methods to Avoid, Reduce and Mitigate impacts to Polar Bears from Oil and Gas Development Specific to the 1002 Area
  - Understand how polar bears respond to disturbance
    1. Use existing movement data to look at relationships with existing infrastructure (does it appear bears are avoiding those areas and if so what is the impact zone)
    2. Monitor for potential disturbances at den sites

- Evaluate efficacy of mitigation measures currently used outside of the 1002 area to determine effectiveness and transferability to the 1002 area
    i. Comprehensive Review of Management Measures (e.g., season/area restrictions, den buffer zones, facility location/design)
    ii. Avoidance: Examine available data to identify areas of particularly high use or biological importance for seasonal or year round avoidance areas
- Develop new mitigation measures specific to the unique characteristics of the 1002 area to reduce the number of bears taken and the overall impact of Industry.

REPORTING TEMPLATE

- **Discipline/Subject Area**: Public Health

- **Lead facilitator** Sara Longan slongan@blm.gov 907-271-3431:

- **Individuals contacted** Once external partners are contacted, the State Department of Health and Social Science (DHSS) are public health experts and have led the multi-agency (federal, state, local) development of past Health Impact Assessments in Alaska. DHSS maintains working relationships and partnerships with public health experts statewide, including contributing authors and experts from the North Slope Borough Public Health Department, among others.

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  907-269-8000

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  907-269-8054

- **What do we need to know and why regarding subjects?** The Health Impact Assessment (HIA) approach is a nationally and internationally used preventive health tool that anticipates the human health impacts of new or existing development projects, programs, or policies. The overall goal of HIA is to minimize negative health effects while maximizing the health benefits of a particular action. Health Impact Assessments are not legally required in the U.S., but have been used statewide in Alaska to address specific interests and concerns raised by affected communities and have typically been used to enhance the "Public Health" analysis requirements driven by the National Environmental Policy Act (NEPA) and associated guidelines.

  The status of human health is generally well understood for North Slope communities, including Kaktovik. Public health and demographic profiles are fully described in the Health Impact Assessments completed for recent North Slope oil & gas leasing and development proposals and actions. These same documents suggest mitigation measures to lessen the effects of potential public health impacts associated with oil & gas development.

- **What information is currently available to address the information needs for subjects?** The Liberty Draft EIS released July 2017 includes a Health Baseline Assessment covering all North Slope villages and Kaktovik. A comprehensive Health Impact Assessment was released in 2013 as part of the Point Thomson Final EIS

and includes the following categories for all North Slope communities, including Kaktovik:

Social Determinants of Health
Accidents and Injuries
Exposure to Potentially Hazardous Materials
Food, Nutrition, and Subsistence Activity
Infectious Disease
Water and Sanitation
Non-communicable and Chronic Diseases
Health Services Infrastructure and Capacity

References:
BOEM, 2017. Liberty Draft Environmental Impact Statement. Bureau of Ocean Energy Management. Prepared by the Alaska Department of Health and Social Services. Available at: https://www.boem.gov/2016-010-Volume-2-Liberty-EIS/

US ACOE, 2013 (2011). Point Thomson Project Health Impact Assessment: Appendix D. Final Environmental Impact Assessment. U.S. Army Corps of Engineers. Prepared by the Alaska Department of Health and Social Services. Available at:
http://www.arlis.org/docs/vol1/AlaskaGas/Report3/Report_PtThom_FEIS/appR.pdf

The Bibliographies for the Liberty and Point Thomson Health Impact Assessments are thorough and could provide supplemental reference materials and source information for additional research on specific public health categories.

NOTE: more current North Slope public health data and information will be available from on-going Health Impact Assessment work supporting the Greater Mooses Tooth 2 and Nanushuk oil & gas projects. Both project locations are distances further from the ANWR 1002 Coastal Plain when compared to the Liberty and Point Thomson projects, but may be evaluated for use in order to supplement and further inform interests as it relates to Public Health considerations made for ANWR 1002 assessments.

- **What are key information gaps?** A health baseline assessment focusing on potential health benefits and impacts from oil & gas exploration and development in the ANWR 1002 Coastal Plain does not exist. Multiple health baseline assessments are complete or in-process for oil & gas projects across the North Slope, which includes a demographic profile, baseline health assessment, subsistence activity profile, summary of harvest data, and potential mitigating factors, etc. as it relates to North Slope communities generally, and specific to Kaktovik. The outcomes and main findings from these recent Health Impact Assessments could help inform environmental assessments and information needs to address management

questions as they relate to Public Health considerations for future oil & gas exploration and development in the ANWR 1002 Coastal Plain.

- **What studies/surveys need to be conducted to fill those information gaps?** Additional health assessments, from what already exists, may not be necessary to evaluate potential health impacts from exploration activities (e.g., seismic). Some level of future Health Impact Assessment may be considered to help inform lease plan reviews and/or specific project proposals for future oil & gas development in the 1002 region.

  Project duration, timelines and costs cannot be determined without understanding the scope and phase (e.g., exploration, leasing, development, transportation, etc.) of the potential Health Baseline Assessment project.

REPORTING TEMPLATE

Discipline/Subject Area: Snow & Climate

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What do we need to know and why regarding subjects?

Development decisions that will be affected by snow/climate information include; seismic exploration*, water availability, and ice road construction*. To better inform decisions on these issues we will need to understand:

1. Snow Depth/Density/Distribution/Snow Water Equivalent to minimize the impacts on vegetation from tundra travel. **(short-term)**
2. Active Layer cycles/depths and their dependence on soil types to better plan routes of tundra travel. **(short-term)**
3. Late Season/ Fall Hydrologic Regimes and end of season snowpack to inform water availability for ice roads. **(intermediate/long-term)**

What information is currently available to address the information needs for subjects?

1. Snow Depth/Density/Distribution: Sporadic but little systematic survey effort. Early surveys were done related to seismic activity, snow cover and tundra damage.
   a. Felix & Raynolds 1989a
   b. Felix & Raynolds 1989b

   Snowfall measurements date back to 1949 on Barter Island but were taken out of service in 1989. New stations were started miles from that site in 1998 and several are currently active (GTN-P network) with data available in the 1002 area from 2001-2015.

   Over the last 5 years the Kuparuk Basin has been surveyed using structure from motion and some LiDAR which can provide ~0.1 m depth accuracy at 2 m spatial resolution. These data products can be produced very quickly after capture but are currently limited in spatial extent.

   c. Nolan et al. 2015

   Since 2002, high-resolution commercial imagery (e.g., WorldView 1-4; IKONOS) have been collected over the 1002. A recent search of the National Geospatial-Intelligence Agency (NGA) database revealed ~30k high-resolution images (1-3 m) available (no assessment of quality control or spectral bands). These images are available at no cost other than processing.

   d. Shean et al. 2016

2. Limited information (both spatially and temporally) is available to capture the variability inside the 1002.

    a. There are 27 plots with thaw depth information spanning several periods between 1984-2009 collected by the refuge staff.
    b. GTN-P stations (mentioned above) monitor freeze/thaw cycles.
    c. There is a network of 20 sites (measurements at depths of 10cm, 20cm, 30cm) from the coast heading south (~110 miles) operated by DNR (Northern Oil & Gas Team) along the Dalton highway corridor. Length of season data have been collected since 1969 but modern data using these stations are available from 2003 (for tundra travel).
    d. Soil survey data at 1:1 million scale is best available from STATSGO.

3. Depths, volume, and sensitive fish species of the 119 largest lakes in the area have been documented (Lyons and Trawicki 1994) but little is known about the watershed area of isolated lakes in this region and the potential for lakes to be recharged during snowmelt following water withdrawal. Although hydrologic studies have been conducted on three large rivers (Pearce et al. 2018) and seven smaller rivers and streams (Lyons & Trawicki 1992), late-season hydrologic regimes are rapidly changing. More information is needed to understand these changes will impact water availability and winter travel. Much of the information about larger climatological trends in and around the refuge is available in the CCP produced in 2015.

What are key information gaps?

1. Snow Cover and Composition across both local and regional gradients of coastal plain
    a. Basic Climatology (i.e., precipitation, wind, temperature)
    b. Remote-sensing information to capture snow depth (e.g., Structure from motion, LiDAR, high-resolution satellite imagery)
    c. Snow density (e.g., what condition does the snow need to be in to minimize impacts of tundra travel)
    d. Snow water equivalent
    e. How snow cover, depth, and wind operate in concert to produce conditions amenable to tundra travel.
2. Active Layer Information
    a. How long does the subsurface need to be frozen and at what temperature/depth? Currently DNR uses a rough standard where ground temps need to be approximately -5° at 30 cm depth. Typically BLM follows this standard.
    b. How do active layer dynamics change based on soil type?
3. End of season snowpack and changing hydrologic regimes in late season (Fall).
    a. How do current climate trends impact alluvial water availability for winter activity in 1002?
    b. How does end of season snowpack contribute to lake recharge potential and water deficit?
    c. How does groundwater connectivity contribute to lake recharge potential?

What studies/surveys need to be conducted to fill those information gaps?

1. A 2016 review of methods to quantify common snow parameters can be found here. A combination of in-situ measurements (e.g., SNOTEL site, weather stations spanning N-S gradient), ground surveys, and remote sensing information will need to be collected. Currently LiDAR and structure from motion (SFM) are promising technologies that could be expanded this winter (FY 18) with limited operations currently scheduled for April. In addition, SFM sensors could be mounted to FLIR aircraft for ~ $10,000 plus processing. Operating a SNOTEL site costs approximately $3,000/yr and approximately $24,000 – $30,000 for installation. Some of the

installation may be offset by NRCS. Long-term access costs will need to be addressed in advance of siting.

2. Active layer can be monitored via weather stations but will also need to be measured with ground surveys. Soil surveys will need to be produced at a finer spatial resolution than is currently available in order to capture some of the variability in the 1002.
3. Compared to Prudhoe Bay, Kuparuk, and the NPR-A, the 1002 area lacks surface water storage in lakes which provide the main water source for ice roads. Much of the water to support winter activity in the 1002 may need to come from isolated lakes, alluvial aquifers, and/or floodplain gravel pits. End of season snowpack surveys and watershed delineation will be important to understand lake recharge potential and water deficiency. Hydrologic monitoring will need to be implemented in selected river basins (e.g., Canning). In the longer term, there is potential to develop late season monitoring technology and methods in more accessible watersheds where stations are already in place and where there is a long-term record (e.g., Kaparuk) and this could be emphasized in 2018 field efforts.

* Relevant state land use regulation: Alaska Statutes (AS) 38.05.035(a)(2) & (7) - Tundra travel permits are authorized by AS 38.05.850.

REPORTING TEMPLATE

> **Discipline/Subject Area:** Subsistence Use

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> **What do we need to know and why regarding subjects?**

Subsistence Legal Mandates and International Agreements

- ANILCA Section 303(2)(B) sets forth the enabling purposes for Arctic National Wildlife Refuge, one of which is to: "(*iii)...*provide the opportunity for continued subsistence uses by local residents".

- Section 810(a) of ANILCA further states: "In determining whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands…the head of the Federal agency…over such lands…shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes. No such withdrawal, reservation, lease, permit, or other use, occupancy or disposition of such lands that would significantly restrict subsistence uses shall be affected until the head of such Federal agency…"

- The International Agreement for Conservation of the Porcupine Caribou Herd obligates the U.S. and Canadian governments to: "conserve the Porcupine Caribou Herd and its habitat through international co-operation and coordination so that the risk of irreversible damage or long-term adverse effects as a result of use of caribou or their habitat is minimized"; and "ensure opportunities for customary and traditional uses of the Porcupine Caribou Herd" by rural Alaska residents and members of Canadian First Nations.

Iñupiat subsistence users – Kaktovik Demographics

- Kaktovik located on Barter Island, is the only village within Arctic Refuge's the coastal plain and nearest to the 1002 area. It would be the community most significantly affected by oil and gas development. Kaktovik is an Iñupiat coastal community with a high dependence upon marine and inland resources for subsistence harvests. In order to consider effects, we need to know the nature, extent and locations of subsistence resources and the cultural and subsistence practices of local residents and evaluate these along with specific oil and gas exploration and operations proposals.

- In 2010, Kaktovik's population was 239 persons with early 90 % of the population being of Native Iñupiat decent (Alaska Census Data, 2010). Participation in subsistence activities by Kaktovik households is high with 95.7 % of households using subsistence resources (ADF&G 2010). The subsistence way of life encompasses much more than just a way of obtaining food or natural materials. It involves traditions, which are important mechanisms for maintaining cultural values, family traditions, kinships, and passing on those values to younger generations. It

involves the sharing of resources with others in need, showing respect for elders, maintaining a respectful relationship to the land, and conserving resources by harvesting only what is needed. Subsistence is regarded as a way of life, a way of being, rather than just an activity (Alaska Federation of Natives 2005).

Kaktovik's Resource Seasonality and Access

- The community's harvest of subsistence resources can fluctuate widely from year to year because of variable seasonal migration patterns of marine and land based mammals, fish and waterfowl. Subsistence harvesting techniques are extremely dependent on changing weather and surface conditions at sea and on land dramatically affecting ability to access resources. Determining when and where a subsistence resource will be harvested is a complex activity due to variations in seasonal distribution of animals, migration patterns, surface access conditions, severe weather events and often complex and changing hunting regulations. Human factors such as timing constraints (due to employment or other responsibilities), equipment (or lack thereof) to participate, and hunter preference (for one resource over another or for one sort of activity over another) are important components in determining the overall community pattern of subsistence resource harvest.

Kaktovik's Mixed Subsistence and Market Economies

- Modern mixed subsistence-market economies require cash income sufficient to allow for the purchase of this mechanical equipment (boats and motors and snow machines) as well as the operational supplies such as fuel, oil, maintenance parts and equipment, firearms, ammunition, nets and traps, etc. Subsistence is focused toward meeting the self-sustaining needs of families and small communities (ADF&G 2000). Participants in this mixed economy supplement their subsistence harvests by cash employment from construction jobs, oil and gas industry jobs, commercial fishing, Alaska Permanent Fund or Native Corporation dividends and/or wages from the public or government services sectors. In Kaktovik, major employers are the North Slope Borough, City of Kaktovik and the Kaktovik Iñupiat Corporation. There are also a few private sector jobs and business such as grocery stores, motels, air carrier services and recreational wildlife viewing and boat transportation providers. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987).

Kaktovik's Subsistence Uses and Conflicts with other Non-local Users

- Various members of the Kaktovik community and the Native Village of Kaktovik Tribal Council (NVK) have raised the issue of low flying planes and helicopters disturbing caribou on the coastal plain and disrupting local subsistence caribou and waterfowl hunters for many years. NVK states that low flying aircraft is causing the caribou to be displaced away from the coastal areas which they access to hunt in the summer and fall seasons. They attribute much of the low flying aircraft use to non-local caribou hunters and recreational scenic and wildlife viewing visitors. They have requested Arctic Refuge for a greater law enforcement presence to prevent this type of activity from harassing wildlife and causing the displacement of local subsistence resources away from the coastal plain areas they depend upon (Native Village of Kaktovik Tribal Council Meetings).

Kaktovik's Subsistence Uses and Oil and Gas Development Conflicts

- During the January 12, 2010, Public Scoping meeting in Kaktovik for the Point Thomson Project EIS, subsistence users of the community expressed significant concerns regarding impacts from development of facilities, pipelines, roads, aircraft and operations, which could displace caribou

and other important species away from coastal areas where subsistence harvesters could access them. In citing past history regarding the original Point Thomson drilling project they said there were many restrictions to subsistence hunting around the project area and they questioned how close subsistence hunters will be allowed to hunt near the drill pads, pipeline, and other facilities, and what new restrictions will be placed upon subsistence users with this new expanding Point Thomson development project (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Barging and fuel spills in marine waters continue to be a major concern as well as the proposed grounding of barges extending a significant distance from shore for lengthy periods of time. This they believe will affect movement of seals and various species of fish which migrate through the area. There are further concerns about the exploration, production and scale of development, and the cumulative impacts of future development over time from other off-shore and inland fields, resulting in an even larger scale of impacts upon their subsistence resources and subsistence use opportunities (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Subsistence users stated there needs for base line studies to determine what fish, waterfowl and marine mammals are in the area, their critical habitat and population levels. This is necessary in case of a major spill or disruptions of migration patterns and timing. They say baseline information is needed in case of a major oil spill and subsequent law suits, citing the case example of the Exxon Valdez oil spill (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- The issue of noise impacts to subsistence users was raised since Kaktovik people travel, camp and harvest in the 1002 area. Commenters stated that helicopter and aircraft traffic and roads and facilities on the ground would result in combined impacts likely to drive caribou and other wildlife further away from the coastal plain areas they hunt. Questions were raised on how much aircraft traffic and vehicle traffic on winter ice and gravel roads will occur and what times of the year (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Concerns were raised about air quality and environmental pollution caused by the burning (pilot purging and flaring) from oil and gas wells. Examples were given citing the black clouds and air pollution seen around the Prudhoe Bay oil fields. They say development of the Point Thomson oil and gas field will bring air pollution that much closure to the community of Kaktovik (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Concerns were expressed that the Point Thomson EIS project is looking only on the small scale, not the long term impacts of future field development and expansion. The project's cumulative impacts do not take into account future development of this field over time, or that of other off-shore and inland fields. The resulting larger scale impacts to resources and our subsistence opportunities are not being fully considered. For example they cite, Prudhoe Bay and all the other surrounding oil and gas field developments and their combined cumulative impacts upon subsistence opportunities (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

Kaktovik's Subsistence Species Harvest Patterns

- Marine Mammals - In years when Kaktovik residents harvest and land a whale, marine resources have composed 59 to 68 % of their total subsistence harvest. Bowhead whaling occurs between late August and early October, with the exact timing depending on ice and weather conditions (Minerals Management Service 2003). There are at least 10 whaling crews in Kaktovik, and the community has a quota of three strikes (whether the animals are landed or not). Kaktovik has what is essentially an intercommunity agreement with Anaktuvuk Pass under which muktuk, whale meat and other marine mammal products (especially seal oil) are sent to Anaktuvuk Pass and Anaktuvuk Pass sends caribou and other land mammal products to Kaktovik (Bacon et al. 2009). Other marine mammal hunting (mainly seals) can take place year-round. Kaktovik

residents also harvest a significant number of bearded and smaller seals, and the occasional beluga whale or polar bear.

- Terrestrial Mammals - Land mammals are the next largest category of harvest, ranging from 17–30 percent in those same years. The primary land mammal resource is caribou, but Kaktovik residents also harvest a significant number of Dall's sheep. Of lesser abundance and availability are muskox, moose and grizzly bears. While Kaktovik hunters have taken moose and muskox, harvest opportunities are significantly restricted due to their low population numbers. Kaktovik's annual caribou harvest fluctuates widely because of the unpredictable movements of the herds, weather-dependent hunting technology, and ice conditions. Caribou hunting occurs throughout most of the year, with a peak in the summer when open water allows hunters to use boats to access coastal and lower coastal plain areas for caribou. In the winter with snow cover snowmachines are used to hunt inland coastal plain, foothills and the north slope drainages of the Brooks Range. Both the Porcupine and Central Arctic caribou herds are hunted when seasonally available. Dahl Sheep are hunted in winter when access by snowmachine is available.

- Fishery Resources - Fish comprise 8–13 % of the total subsistence harvests. Fish may be somewhat less subject to variable surface access conditions but still exhibit large year-to-year variations. In some winter months, fish may provide the only source of fresh subsistence foods. Kaktovik's harvest effort seems to be split between Dolly Varden and Arctic Cisco, with the summer fishery at sites near Kaktovik being more productive than winter fishing on the mid and lower reaches of the Hulahula River.

- Bird Resources - Birds and eggs harvest makes up 2–3 % of the total harvest. Since the mid-1960s, subsistence use of waterfowl and coastal birds has been growing at least in seasonal importance. Most birds are taken during the spring and fall migrations. Important subsistence species are black brant, long-tailed duck, eider, snow goose, Canada goose, and pintail duck. Waterfowl hunting occurs mostly in the spring from May to early July (Minerals Management Service 2003). Ptarmigan are also a seasonally important bird.

- Furbearer Resources - Trapping of furbearers in the Kaktovik area has decreased with time. Furbearers are taken in the winter when surface travel by snowmachine is possible. Hunters pursue wolf and wolverine by searching and harvesting them with rifles primarily between March and April or in conjunction with winter sheep hunting. Some hunters may go out in the fall or early winter, but usually weather and snow conditions are poor at that time and people are more concerned with meat than with fur.

Kaktovik's Subsistence Harvests Data

- Community subsistence harvest data for Kaktovik is dated in terms of the in-depth subsistence community use surveys, which were conducted in 1985, 1986, 1992 (ADF&G). In 1995, the North Slope Borough (NSB) began to systematically collect subsistence harvest data for the eight villages in the Borough. However, the NSB was only able to collect subsistence harvest data for the village of Kaktovik in 1994-1995 and in 2002-2003.

- Subsistence harvest studies for Kaktovik in 1995 indicated that 61% of the subsistence harvest (in edible pounds of food) were from marine mammals, consisting of bowhead whales, bearded seals, ringed seals, spotted seals, polar bears, and beluga whales. Terrestrial mammals comprised another 26% of the estimated edible pounds harvested, consisting of caribou, Dall's sheep, muskox, moose, and brown bear. Fishery resources accounted for 11% of the estimated total edible pounds of harvest. Seven species of fish accounted for the 4426 fish harvested of which Arctic Cisco and Dolly Varden represented 4233 of the fish caught. The harvest of birds

accounted for the remaining 2% of edible pounds of subsistence harvest with 530 birds reported harvested (Brower et al 2000).

- In addition to the Beaufort Sea, Kaktovik residents have access to a number of rivers and lakes, which support significant subsistence fish resources. Pedersen and Linn (2005) conducted surveys of the Kaktovik subsistence fishery in 2000-2001 and 2001-2002, with estimated community harvests of fish at 5,970 pounds and 9,748 pounds, respectively. Dolly Varden, lake trout, and Arctic Cisco were the only fishery resources reported harvested by Kaktovik households in this study. Dolly Varden was the most commonly harvested fish in terms of numbers harvested and estimated harvest weight, with Arctic Cisco and lake trout ranking second and third (Pedersen and Linn, 2005).

Gwich'in Subsistence Users of interior Alaska and Canada

- Gwich'in people of northeastern Alaska and northwestern Canada have opposed drilling and development on the Refuge's coastal plain (1002 area) because its importance as a primary calving and post-calving habitat for the Porcupine Caribou Herd. These communities are heavily dependent upon subsistence uses of caribou from this herd even though they live a considerable distance from the Alaska's coast plain. Oil and gas development is seen as a threat to the safety or success of calving season and therefore, a potential impact to the health and population of the Porcupine Caribou herd to which they are dependent upon.

- Porcupine caribou are the primary subsistence resource of the Gwich'in people. In Alaska, Arctic Village and Venetie are located strategically along the herd's migration paths and they depend on the herd for their physical, cultural, social, economic and spiritual needs. In Arctic Village, caribou and moose constitute more than 90% of their subsistence harvest in weight in most years. And in Venetie, caribou constitute up to 71% of their subsistence harvest in some years (ADF&G Community Subsistence Information System).

- To the Gwich'in people the Refuge's coastal plain including the 1002 area where the Porcupine herd calves is considered a "sacred place where all life begins". Opening the 1002 area to oil and gas exploration and development threatens both the porcupine caribou and the Gwich'in way of life (Gwich'in Steering Committee, 2012).

- Any significant reduction or loss of the Porcupine Caribou Herd would have a substantial impact upon the Gwich'in communities. There is a need for an analysis of the economic value of caribou to subsistence users, and the potential economic impacts that might result if the herd is negatively affected by oil and gas exploration and development on the 1002 area.

> **What information is currently available to address the information needs for subjects?**

- Kaktovik's subsistence Use: The most recent and thorough publication regarding Kaktovik's subsistence and traditional land/marine water use patterns were prepared for the US Army Corps of Engineers Point Thomson Project EIS and published in July 2012. Appendix Q of the final EIS and Environmental Impact Statement contains the information on the "Subsistence and Traditional Land Use Patterns for Kaktovik and Nuiqsut" which was prepared by Stephen Braund and Associates at the request of HDR Alaska for the US Army Engineer District Alaska Regulatory Division.

- The Point Thomson Project is located adjacent to Arctic National Wildlife Refuge on coastal plain approximately 60 miles west of Kaktovik. In describing the affected environment for subsistence, the study team reviewed the Point Thomson Environmental Report (ER) (ExxonMobil 2009), as well as other sources of subsistence data including harvest amount data obtained from the

Alaska Department of Fish and Game (ADF&G) Division of Subsistence and North Slope Borough (NSB) Department of Wildlife Management subsistence publications. The ER included harvest data for the majority of available study years. Appendix Q includes additional harvest amount and harvest location data, including unpublished subsistence harvest data from the ADF&G Division of Subsistence and the NSB Department of Wildlife Management acquired in 2002 and unpublished subsistence harvest data acquired from the NSB in 2010. It incorporates additional data from previous Environmental Impact Statement (EIS) efforts, including issues raised during a Point Thomson EIS meeting on caribou in 2002 and subsistence use area data collected in Kaktovik in 2003. Finally, this affected environment incorporates 1995-2006 subsistence use areas collected during a Minerals Management Service (MMS) funded subsistence mapping project in Kaktovik and Nuiqsut (SRB&A 2010a).

- There is a significant lack of current and contemporary subsistence and harvest information for the villages of Arctic Village and Venetie. Ethnographic and socio-economic information is not available to assess subsistence uses and impacts to these communities if substantial declines to the Porcupine Caribou Herd occur as a result of oil and gas development and production.

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> **What are key information gaps?**

- Currently there is no complete synthesis of cultural work (subsistence, historical, and archaeological) that has been conducted in the Arctic Refuge as a whole or in particular for the northern half of the Refuge. A limited number of archeological and historical resource surveys have taken place on the Refuge due to funding, logistical difficulties of working in remote locations and lack of infrastructure to support investigations in the Refuge. A more through and complete synthesis of what work has been completed and in what areas would help identify informational gaps and help set priorities for future work.

- Community subsistence harvest data for Kaktovik is dated in terms of the in-depth subsistence community use surveys, which were conducted in 1985, 1986, 1992 (ADF&G). In 1995, the North Slope Borough (NSB) began to systematically collect subsistence harvest data for the eight villages in the Borough. However, the NSB was only able to collect subsistence harvest data for the village of Kaktovik in 1994-1995 and in 2002-2003. There needs to be a more through and consistent collection of community subsistence harvest information.

- In 2010, Morgan Grover of the US Army Corps of Engineers conducted a survey of 70 known cultural sites along the coastal areas from Flaxman Island to the Canadian border (including the 1002 area) to examine the effects of environmental changes and erosion has had on these sites over the past 30 years. The study concluded that of the 69 previously reported cultural sites, 21 were found to be impacted to some extent by erosion or thermokarsting, and 20 had been completely eroded away. She concludes that many of the remaining cultural sites are in imminent threat of eroding in the next decade. Follow-up studies and research is needed to recover cultural information before it is lost to erosion. The report strongly recommended that selected threatened sites be documented and potentially excavated after consultation and agreement with Tribal leaders.

- In 1982, Ed Hall conducted an inventory and survey of archaeological and historical resources in the 1002 area examining areas of high archaeological and historical potential. The areas surveyed were focused on areas proposed for exploratory drilling for oil and gas and areas more likely to have cultural sites such as coastal areas and barrier islands, and along rivers and streams that crossed the 1002 area, and high points of land that have overlooks above the surrounding tundra. There is a need to reassess these areas since visitors and users have reported several graves, human remains and artifacts in these areas that have not been documented and record by professional cultural resource staff.

- The Porcupine Caribou Herd is of great importance as a major subsistence resource for both the Iñupiat and Gwich'in users in Alaska. Impacts to this herd could have significant ramifications on their traditional way of life and economics. There is a need for an analysis of the economic value of caribou to subsistence users, and the potential economic impacts that might result if the herd is negatively affected by oil and gas exploration and development on the 1002 area.

> **What studies/surveys need to be conducted to fill those information gaps?**

- Hire one Archeologist/Anthropologist GS-11/12: USFWS should hire an archeologist or anthropologist to oversee the agency's cultural resource management/compliance programs during the seismic, exploration and production phases of the oil and gas development associated with the 1002 area of the coastal plain.

- Manage Subsistence Use Data: Compile a complete synthesis of archaeological, ethnographic and subsistence work that has been completed for Arctic Refuge's north slope and 1002 areas and create a functional repository of existing contemporary and historical data. Multiple sources of published and unpublished subsistence use and harvest data reside with various agencies, organizations, tribal governments, and universities.

- Identify gaps in data: A comprehensive review of existing information is needed to identify gaps in the data and to identify priorities for future subsistence research and monitoring. This information is needed to ensure traditional subsistence use and knowledge is thoroughly and accurately considered in Federal and State proposals for subsistence regulations, as well as Refuge management actions including oil and gas development in the 1002 area.

- Establish a Subsistence Harvest Monitoring Program: A NSB/Kaktovik community supported harvest monitoring program with implementation protocols based on timely and accurate harvest information is needed to ensure long-term conservation of subsistence species of fish and wildlife and subsistence uses for qualified subsistence users. The majority of the ethnographic and subsistence data for Kaktovik and the 1002 area was collected in the 1980s and may not accurately portray current patterns in subsistence use, demographics, harvest amounts, hunting seasons, locations, or community needs.

- Conduct Oral Histories and Traditional Knowledge Study: Much valuable cultural, historic, and traditional ecological knowledge about the Refuge and the coastal plain (1002 area) is possessed by local elders. Oral histories and place names contain an enormous amount of information on traditional uses, culturally important places, historic camps and settlements, and other natural and cultural information. This information is an untapped archive that could potentially benefit historical site protection and guide management decisions setting priorities for surveys and research in the 1002 area.

- Need for an analysis of the economic value of caribou to subsistence users, and the potential economic impacts that might result if the herd is negatively affected by oil and gas exploration and development on the 1002 area.

1002 Vegetation, soils, permafrost, and wetland Resource Assessment, February 16, 2018

- Discipline/Subject Area. Vegetation, soils, permafrost, and wetlands

- Lead facilitator.

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- **What do we need to know and why regarding subjects?**

  1) We need distribution maps of vegetation and wetland types, plant growth forms, soil types, near-surface ground ice, snow regime and soil depth above permafrost across the 1002 area. We also need descriptions of these types and information on relationships between them, snow patterns and human or natural disturbance. The region is particularly sensitive to surface disturbance due to the relationships between vegetation, soil water content, soil type, and permafrost. To minimize the impact of development activities and to facilitate restoration land managers will require an accurate map of sensitive habitats. In the near term this is needed to design stipulations for a seismic program that minimizes persistent damage by routing vehicles over less sensitive areas and requiring adequate snow cover and soil conditions.
  2) Impacts to be expected from three phases of oil exploration and development, and mitigation measures for each. A) Impacts if seismic exploration is done in 1002 area using current technology (eg overland vehicle travel). B) Impacts from exploratory well phase (eg temporary well pads, ice roads, overland vehicle travel). C) Impacts from production phase (eg gravel roads and pads, infrastructure). For each, we need information on short and long term impacts likely to plants, soils, permafrost and wetlands, including information for different vegetation communities, species, soil types and soil moisture conditions and for overland travel by different types of vehicles under different snow conditions. This information is needed to manage new seismic

exploration in the 1002 area and subsequent development and to design appropriate stipulations and mitigation measures.

- **What information is currently available to address the information needs for subjects?**

For 1 (above):

Classification and description of natural vegetation, soils, permafrost and wetlands of 1002 area and of the North Slope in general: Vegetation types are determined by many factors including soil texture, moisture, age and chemistry, soil depth above permafrost, slope, snow depth in winter and climate effects of distance from the coast. Vegetation is dominated by shrubs and sedges, mainly less than 2 feet tall, with a moss ground cover. Vegetation cover is nearly 100% except on floodplains. Most of the area is classified as wetlands because permafrost is near the surface and hinders soil drainage. Thaw of soil in summer is hindered by an insulating blanket of thick layers of organic soils and moss. Less than 3 feet thaws down from the surface in summer and often only ~1 foot. Large amounts of soil ice accumulate in the near-surface permafrost (often 20 – 60% of soil volume) and ice is subject to thaw if the organic layer is damaged leading to surface subsidence. About half of the 1002 area has a honeycomb-pattern surface microtopography ("polygon tundra") caused by uneven distribution of ice in the near-surface permafrost, which shows it is prone to subsidence if disturbed. The Arctic NWR 2015 Comprehensive Conservation Plan synthesizes much of the available information on these topics.

U.S. Fish and Wildlife Service. (2015). Arctic National Wildlife Refuge comprehensive conservation plan. U.S. Fish and Wildlife Service, Region 7. https://www.fws.gov/home/arcticccp/.

Maps of natural vegetation, soils, permafrost and wetlands of 1002 area:

While there is much information available for the North Slope on these topics, the tight relationships between them and their susceptibility to disturbance, there are no accurate maps of them for the 1002 area.

Vegetation Maps:

Two state-wide vegetation maps exist (NLCD and Landfire) but the scale of mapping and accuracy are inadequate for planning purposes. Ducks Unlimited produced a map of the North Slope on contract for the North Slope Science Initiative in ~2015, but used existing maps where available; maps from 1994 and 1984 were used for the Arctic Refuge portion. No new imagery classification was done for the 1002 area.

The most detailed vegetation map of the 1002 area is from 1994.

Jorgenson, J.C., Joria, P.E., McCabe, T.R., Reitz, B.E., Raynolds, M.K., Emers, M., & Wilms, M.A.(1994). User's guide forthe land-cover map of the coastal plain of the Arctic National Wildlife Refuge. In (p. 46). Anchorage, AK: U. S. Fish and Wildlife Service.

Wetlands Maps:

The National Wetland Inventory (NWI) is the only avaiable wetland map. The scale and accuracy are inadequate for planning purposes.

U. S. Fish and Wildlife Service. May 2014. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/wetlands/

Soils Maps:

Two general soils maps exist for the 1002 area, STATSGO2 and the Ecological Landscape Map of Northern Alaska. Both are at 1: 1M scale and are inadequate for finer scale planning purposes.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. U.S. General Soil Map (STATSGO2). Available online.

Permafrost Maps:

Jorgenson, M. T., M. Kanevskiy, Y. Shur, J. Grunblatt, C. L. Ping, and others. 2015. Permafrost database development, characterization, and mapping for northern Alaska. Report for Arctic Landscape Conservation Cooperative by Alaska Ecoscience and University of Alaska Fairbanks. 46 p.

Topographic Maps:

A new digital elevation model is available, from which topography information can be derived. Terrain of the 1002 area is hillier than the parts of the North Slope that have had oil development thus far and has higher elevations and more sloped terrain.

For seismic exploration, 2-A (above):

Information on vegetation, soils, permafrost or wetlands impacts and recovery from vehicle traffic during seismic programs between 1984 and 2001:

Three studies of vegetation and soils impacts from seismic exploration conducted before 2002 generally had similar results showing that overall, vegetation impacts did occur on over half of the trail length but were generally low and mostly recovered in the first decade. Trail visibility was rated separately and usually recovered over the first few years. The studies showed that

some vegetation types were more impacted than others and recovered more slowly, including drier soil conditions more than wetter and shrubby types more than sedge types. All three documented more damage and less recovery on camp move trails than on seismic lines. Two studies tracked recovery for at least 15 years, showing that 10 – 20% of the camp move trails were still disturbed 15 years after exploration. This was sometimes due to ground subsidence that caused the trail to become a wetter trough. Higher damage on camp trails was attributed to the use of higher ground pressure vehicles and the sheering action of camp trailers on skis pulled across the tundra by tractors. Management implications and mitigation measures were discussed.

The study of 1980s seismic trails in the Arctic Refuge also highlights the need to monitor disturbed areas for at least five years afterward exploration. Depth to permafrost, trail subsidence and plant community dissimilarity measures increased gradually on trails over the first four years after exploration.

Jorgenson, J.C., Hoef, J.M.V., & Jorgenson, M.T. (2010). Long-term recovery patterns of arctic tundra after winter seismic exploration. *Ecological Applications, 20*, 205-221

Jorgenson, M. T., J. E. Roth, T. C. Cater, S. Schlentner, M. E. Emers, and others. (2003). Ecological impacts associated with seismic exploration on the central arctic coastal plain. Final Report for ConocoPhillips Alaska, Inc., Anchorage, AK, by ABR, Inc., Fairbanks, AK, 76 p.

Yokel, D., and J. M. Ver Hoef. (2014). Impacts to, and recovery of, tundra vegetation from winter seismic exploration and ice road construction. (2014). BLM Arctic District, Fairbanks, AK, 61 p.

Information on vegetation, soils and permafrost impacts from Alaska DNR tundra travel modeling study 2003 - 2004:

This study developed a model to predict impacts of winter vehicle travel under different snow/freeze conditions and in different types of vegetation, in order to develop objective and easily measurable criteria for opening the tundra travel season. They tested different vehicle types on tundra in winter and the following summer recorded variation in soil temperature, soil depth to permafrost and photosynthetically active radiation absorption on the resulting tracks and control plots. Changes to these variables were minor, but did vary by vegetation types and did decrease as winter progressed. In the subsequent validation study they tested a disturbance ranking system more similar to those used in the three studies cited above. This showed that vegetation damage and surface depression did occur during the early winter dates tested and decreased greatly at later dates, related to greater snow density and deeper soil freeze. It also showed more impacts from vehicles with greater pounds per square inch.

Bader, H. R., and Guimond, J. (2004). Tundra Travel Modeling Project. Alaska Dept. of Natural Resources, Division of Mining, Land and Water. 65 p.

Bader, H. R. (2005). Tundra Travel Modeling Project: validation study and research recommendations. Alaska Dept. of Natural Resources, Division of Mining, Land and Water. 20 p.

Information on vegetation, soils, permafrost or wetlands impacts and recovery from seismic programs conducted in Alaska in the past 15 years (2002 to present):

No published papers and no in-house reports found yet, either from state or federal lands.

For 2-B and 2-C (above):

Known issues with infrastructure in the production phase include habitat loss from gravel pads and roads, habitat fragmentation due to long linear structures (roads), alteration of surface hydrology, thawing of permafrost and ground ice, introduction of non-native species and road dust effects on plants. Summaries are given in these documents.

National Research Council. (2003). *Cumulative environmental effects of oil and gas activities on Alaska's North Slope*. National Academies Press.

Raynolds, M. K., Walker, D. A., Ambrosius, K. J., Brown, J., Everett, K. R., Kanevskiy, M., ... & Webber, P. J. (2014). Cumulative geoecological effects of 62 years of infrastructure and climate change in ice-rich permafrost landscapes, Prudhoe Bay Oilfield, Alaska. *Global change biology*, *20*(4), 1211-1224.

- **What are key information gaps?**

For 1)

Vegetation maps: There is a great deal of descriptive information on vegetation and its relation to physical factors but no detailed high-accuracy map exists. The 1994 map of 1002 area had a measured accuracy of 52% for 18 vegetation classes. The age and low accuracy make this map inadequate for planning of industrial operations or stipulations on vehicle routing.

Soils, permafrost and wetlands maps: To date data have been collected to increase our knowledge of general landscape processes at a broad scale. These data do not meet the accuracy or resolution required to develop infrastructure or manage this remote landscape in conjunction with industrial use. No detailed high-accuracy maps exist for soils, permafrost or wetlands. Maps have been developed from limited or old data with little field validation and at scales lacking enough detail to effectively facilitate exploration, development, and restoration.

More information is needed on the seasonal soil freeze/thaw and snow pack/melt cycles in the 1002 area to determine stipulations for opening and closing the tundra travel season.

For 2-A) To predict and manage impacts from new seismic exploration in the 1002 area and design appropriate stipulations and mitigation measures, we need to know how impacts would be different from the substantial impacts documented in papers and reports about seismic

programs conducted on the North Slope between 1984 and 2001. Current NEPA documents for seismic programs state that impacts will be negligible due to improvements in technology, much less than those documented earlier, but we have found no follow-up studies or data to be able to evaluate this. We particularly need information from current or recent exploration in hillier terrain since those areas are more similar to terrain in the 1002 area.

For 2-B & C) Development beyond the seismic exploration stage in 1002 area would probably follow the trajectory of the Alpine Field or another newer field, rather than the older Prudhoe Bay field. We need information on the history and current status of these fields.

- **What studies/surveys need to be conducted to fill those information gaps?**

For 1) A database of geographic information for the 1002 area is needed. Layers would include:

New vegetation map.

Updated wetlands map

Soils map with field validation at a 1:63,000 scale

Map of permafrost characteristics and depth of soil active layer

Topography from most recent DEM

Terrain sensitivity map, modeled using the above layers

Cost estimate $1,500,000 – $3,000,000. Field validation for vegetation, soils, permafrost and wetlands could occur at the same time.

For 2-A) Studies of impacts and recovery from seismic exploration currently occurring on North Slope are needed. Do a literature search for draft or in-house documents regarding any follow-up done after seismic exploration conducted on the North Slope in the past 15 years. Information about exploration in hillier terrain would be most useful. Cost estimate: staff time only, but requires work by staff from multiple agencies.

For 2-B & C) Summary of history and current status of Alpine oil field or other newer oil fields on North Slope. Cost estimate: staff time only, but requires work by staff from multiple agencies.

Arctic Refuge 1002 Visitor Use Technical Report

Discipline/Subject Area: Visitor Use

Lead facilitators: Jennifer Reed, Arctic Refuge (907) 455-1835; and Tracy Fischbach, FWS RO Refuges (907) 786-3369

Individuals contacted: Roger Kaye, Wilderness Discipline/Subject Area Lead; Hollis Twitchell, Subsistence Use Discipline/Subject Area Lead; Steve Berendzen, Arctic Refuge Manager; Tom Bickauskus, BLM State Lead for Recreation, NLCS, NHST and W&SR

What do we need to know and why regarding subjects?

Definition of "Visitor": The term "visitor" includes any non-local person who takes part in recreation activities on the Refuge.

What and Why: Understanding current characteristics of visitor use (amount, type, timing, and distribution of visitor activities and behaviors), and visitor experiences (perceptions, feelings, and reactions that a visitor has before, during, and after a visit to an area) is essential to evaluating, and possibly minimizing, the effects of oil and gas development and infrastructure upon visitors, and commercial operators that support those visitors. However, because management of the Arctic Refuge has not required visitor registration or field contacts, information about what, where, and how visitor activities occur is limited.

Effects of highest concern on visitor opportunities and experiences include:

- Changes in opportunities for immersion in the area's wild character; its freedom from the human intent to control, alter, or manipulate its components and ecological and evolutionary processes.
- Changes to desirability of the destination (visitor displacement resulting from new user types; and/or increased visitation by new user types).
- Changes to the timing or availability of access for recreation (both consumptive and non-consumptive uses).
- Changes to the distribution of visitors, possibly leading to crowding.
- The emergence of new behaviors, modes of travel, or activity types, possibly leading to social conflicts.
- Reduced scenic opportunities due to changes to apparent naturalness by the addition of man-made structures.
- Reduced auditory quality due to addition of man-made noise to the natural soundscape.
- Reduced quality of night sky visibility due to atmospheric light pollution.
- Reduced opportunity for solitude. Solitude coincides with the Refuge CCP where it is defined as being free of the reminders of society, its inventions, and conventions. Solitude is greater than just being isolated from other people.

- Reduced opportunities for immersion in undeveloped area void of permanent structures or modern human occupation. Changes to levels of visitor satisfaction resulting from changes in overall quality of recreational opportunities.
- Changes to the quality of visitor experience could affect demand for commercial services among the majority of guide and air transporting businesses.
- Changes to the frequency of commercially-supported services may further limit managers' capacity to deliver quality visitor opportunities, since managers rely heavily upon the interests of commercial service providers to act as our eyes, ears, and workforce to deliver services.

What information is currently available to address the information needs for subjects?

Known Access Points/Routes used for Primitive/Unconfined Recreation: There are multiple areas and/or routes of known historic interest and sensitivity to visitors of the Coastal Plain:

- The historic caribou calving ground areas in May and June;
- Known caribou migration viewing areas allowing reasonable access in June and July including the following unimproved landing areas: Jago Bitty, Lower Marsh Creek, Lower Canning River; Kataktuiruk River, Aichilik River;
- Known abundant and diverse bird sighting areas include the Kaktaktuiruk River and Canning River delta June-July;
- Routes from the Neruokpuk Lakes Complex through the Arctic Coastal Plain from March until September (includes spring ski touring);
- The route stemming from the Sadlerochit Mountains along the Kataktuiruk River to Brown Low Point
- Canning River due to its non-technical rating and floatability all summer June until September (flow); whereas the Hulahula and Kongakut are experiencing lower water levels than historically seen (Hulahula receives high winds all winter and is a "scour point" so lower water and less floatable than past);
- Coastal lagoons between Hulahula River and Kongakut River, providing paddling access to Kaktovik during open water, from June through October; and,
- Coastal Lagoons which are Marine Protected Areas in the fall from July until freeze-up (recently mid-late October) for polar bear viewing.
- Packrafting routes including Upper Marsh Fork to Kaktovik; Arctic Village to Kaktovik; Neruokpuk Lakes Complex to Kaktovik; and Turner River to Kaktovik, with resupplies at major river crossings.

Two known reports on Visitor Use:
Arctic Refuge. 2011. Arctic National Wildlife Refuge Public Use Summary
This report, based on available indirect visitor data obtained through commercial client use reporting, and analyzed through 2009, provides a summary of historic visitor use information compiled for the area now designated within the Arctic National Wildlife Refuge boundary (up to 1997); depicts a general index of recent visitor use patterns (1998-2009) based upon available data; summarizes available harvest data for general hunting and trapping through 2009; and discusses current trends in public use with implications for future management practices.

Christensen N. and L. Christensen. 2009. Arctic National Wildlife Refuge Visitor Study: the characteristics, experiences and preferences of Refuge visitors
This report summarizes data directly collected from visitors and shows that:

- The greatest positive influence on visits came from experiencing the components of "Wilderness" (92%), "A Sense of Vastness" (92%), "Remoteness and Isolation" (89%), "A Sense of Adventure" (84%), and 'Natural Conditions" (84%).
- Refuge purposes most frequently rated as "Very Important" were "Wildlife"(97%), "Wilderness"(96%), "A bequest to future generations"(89%), "Remoteness and isolation"(89%), and 'A place where natural processes continue"(86%).
- Respondents encountered an average of two other groups on their trip, saw or heard four airplanes, and saw an average of one site with evidence of previous visitor use.

What are key information gaps?

- Baseline information on most of the concerns listed above as "Effects of highest concern on use opportunities and experiences."
- River floating, one of the main river activities, requires adequate flow. There is limited information about the Refuge's most-visited rivers.
- Fishing is a secondary activity enjoyed by many visitors who float the Refuge's rivers; the extent, to which fishing on the Canning and Hulahula Rivers occurs, among other Coastal Plain destinations, is unknown.
- There is no information about the number of people who visit the Refuge without using commercial services or about what activities they participate in.
- Client Use Reporting (CUR) by commercial air transporters does not provide consistent data about transported visitors' specific access areas and no data is requested for egress areas; therefore, there is no trip length data available from reports. CUR also does not include visitor's primary activity.

What studies/surveys need to be conducted to fill those information gaps? Please include duration (start and end), staffing and cost estimates.
<u>Ongoing efforts that could be focused or modified to meet needs:</u>

- Evaluate existing OMB-approved FWS visitor surveys for generalized information about Alaska Region's visitation patterns and preferences (duration: XX; lead: Natalie Sexton/Debbie Steen?; cost: XX).
- Re-evaluate 2009 visitor survey data held by Neal Christensen, to identify any possible additional information about experience condition expectations of visitors, specific to the Coastal Plain (duration: 3 months after contracted; lead: Jen Reed?; cost estimate: $10K?)
- Repeat/focus Arctic Refuge Visitor Survey to obtain current data about expectations of visitors, specific to the Coastal Plain (warning: dependent upon OMB approval) (duration: lead: XX, cost estimate: XX).
- Evaluate Refuge's raw 2010-2011 Client Use Report (CUR) data, consistent with previous data, to identify additional information specific to the Coastal Plain; and of Refuge's limited 2012-2017 CUR data (reporting requirements inconsistent with previous

data). (duration of effort: 6 months; lead: Reed; cost estimate: $3K for contracted database support).

New efforts that are short-term priorities, since baseline data currently does not exist:

- River flow data (duration: XX, lead: XX, cost estimate: XX).
- Viewscape baseline study (including visible pollution plume resulting from air quality affecting viewscape) to document visual resource conditions and potential future changes to existing undeveloped viewshed (duration of sampling: March-Oct, lead: XX, cost estimate: XX).
- Soundscape baseline study to document auditory resource conditions and potential future changes to existing natural sound environment (duration of sampling: March-Oct, lead: XX, cost estimate: XX).
- Night sky baseline study to document auroral, stargazing, and other astronomical resource conditions and potential future changes to existing night sky opportunities (duration of sampling: March-Oct, lead: XX, cost estimate: XX).

What management actions could be conducted to fill some information gaps?

- Require air transporters to obtain primary visitor activity by unguided but transported (plane or motorboat) visitors.
- Require primary access locations to be reported as lat/long.
- Develop a voluntary registration system for non-guided, non-commercially transported visitors.

Water Resources

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Alan Peck; Soil, Water, & Air Program Lead; Bureau of Land Management, State Office, KPeck@BLM.gov, 907-271-4411 **What do we need to know and why?**

The Alaska National Interest Lands Conservation Act (ANILCA) explicitly directs the U.S. Fish and Wildlife Service to ensure water quality and quantity for the conservation of the natural diversity of fish, wildlife and their habitats:

(i) to conserve fish and wildlife populations and habitats in their natural diversity……

(iv) to ensure, to the maximum extent practicable and in a manner consistent with the purposes set forth in paragraph (i), water quality and necessary water quantity within the refuge.

Winter seismic and other oil exploration activity will involve temporary infrastructure and withdrawals of large volumes of water that could have substantial short-term or long-term impacts to hydrology, water quality, fish and wildlife populations, and habitats. Development and production will involve even larger water withdrawals, gravel extraction from floodplains for permanent infrastructure, and generation and storage of hazardous wastes. These practices will result in increased potential for contamination, alteration of surface and groundwater hydrology, and additional impacts to fish and wildlife habitat.

To ensure legal mandates are met during exploration and development and allow for science-informed impact assessments, NEPA processes, best management practices (BMPs), and permit stipulations the following information is necessary:

- Identification of high-value and vulnerable aquatic habitats and critical hydrologic processes by season to ensure sufficient water is available to meet refuge mandates.
- Evaluation of the efficacy, applicability and transferability of BMPs, permit stipulations and mitigation measures used in the NPR-A for use on the coastal plain, 1002 area (per National Research Council (NRC) 2003) for all phases of industrial activity (seismic, exploration, development, restoration). This evaluation must recognize and understand the implications of the stark hydrologic and topographic differences between the coastal plain, 1002 area and areas with ongoing development:
    - Water covers 20.2% of the developed area in NPR-A, but only 1.6% of the coastal plain, 1002 area where large expanses of land are nearly devoid of lakes (figure 1).
    - Most lakes in the coastal plain, 1002 area are isolated from major drainages with limited recharge and may be more vulnerable to water withdrawals.

- Most flowing waters in the coastal plain, 1002 area are alluvial mountain streams.
- Groundwater-fed springs are unique to the coastal plain, 1002 area and provide critical habitat for extraordinarily high concentrations of invertebrates and overwintering fish.
- The relatively steep terrain and lack of water in the coastal plain, 1002 area will make it necessary to employ alternative untested practices.

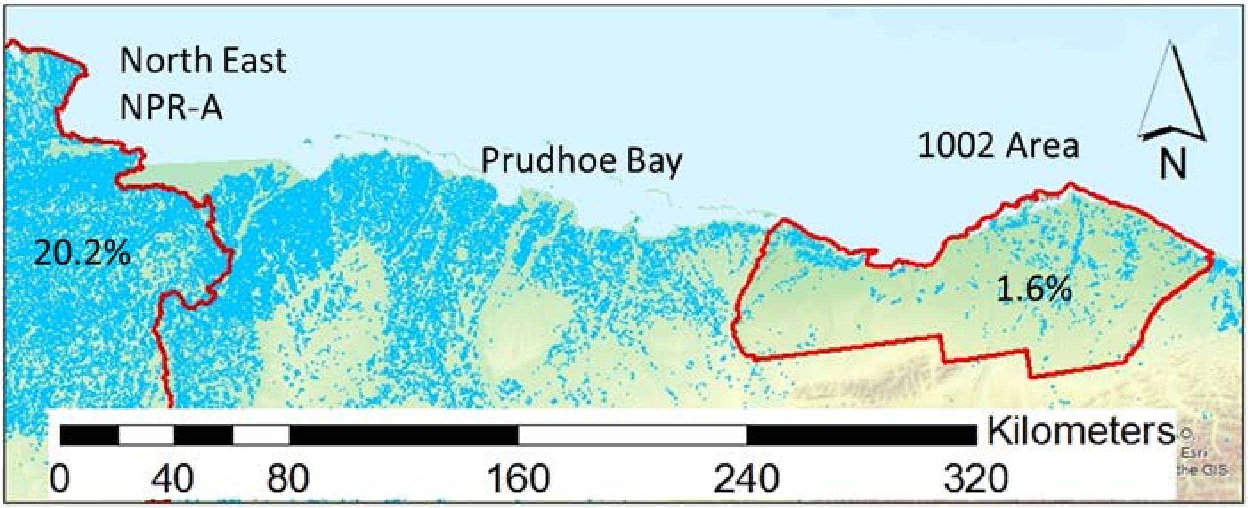

Figure 1. Surface water extent in the coastal plain, 1002 area and north eastern NPR-A planning area.

What information is currently available to address the information needs?
Most water resource studies were conducted nearly thirty years ago and include the following:

Rivers:

- Continuous hydrologic monitoring: five-plus years for three large rivers (USGS 2018) and four-plus years for seven smaller rivers during the open water season (Lyons and Trawicki 1994). The longest and only ongoing monitoring is on the glacier-fed Hulahula River (2011-2018).
- Quantity of liquid under ice hummocks in large rivers during winter (Lyons and Trawicki 1994)
- Limited water quality and channel geometry: Single sampling event for a limited suite of parameters on 11 streams and rivers (Childers et al. 1977)
- Documentation of fish: Sensitive species have been documented in all major rivers
- Groundwater springs: Reconnaissance inventory of spring locations with limited data on hydrology, macroinvertebrates, chemistry and aufeis extent (Childers et al. 1977)

Lakes:

- Water quantity (one-time sampling events):
  - Bathymetry and winter water availability of 115 of the largest lakes (Trawicki et al. 1991)
  - Elevation of lakes and marginal wetlands of 150 of the largest lakes (Bayhas 1996)
- Water quality: Summer sampling of 36 small lakes (Synder-Conn and Lubinski 1995), late fall sampling of 7 large lakes, and late winter sampling of one large lake (Childers et al. 1977).
- Fish:
  - Reconnaissance surveys targeting nine spine stickleback identified stickleback in 34 of 52 lakes surveyed (Trawicki et al 1991). More intensive surveys of 22 lakes documented nine spine stickleback in 10 lakes and more sensitive species in 6 lakes (Wiswar and others).

A Remote sensing inventory identified lakes of sufficient depth to support overwintering fish (Grunblatt and Atwood 2014).

What are key information gaps?

Seismic and exploration will involve water withdrawals and temporary infrastructure. Prior to activities, the following questions need to be answered to allow for science-informed decisions:

- How effective are existing BMPs and mitigation measures used in the NPR-A at ensuring protection of habitat? Will they ensure protection of habitat in the coastal plain, 1002 area? According to the NRC (2003), these questions have not been answered.
- What habitats or areas need additional protection due to their vulnerability and/or high-value to fish, waterbirds, other wildlife, recreation, and subsistence?
- What is the status and natural variability in water quality and quantity of rivers and lakes? This information is necessary to allow for impact assessments and adaptive management practices.

During development, production and restoration phases, water use, alteration of surface and ground water hydrology and potential for contamination will increase. Prior to water withdrawals, drilling, leasing, gravel extraction, permanent infrastructure, injection of hazardous waste, and restoration the following questions need to be answered to allow for science-informed decisions:

- What BMPs, mitigation measures, and restoration standards will ensure protection of habitat from impacts of development in the coastal plain, 1002 area where there are considerable differences in hydrology, terrain, and management purposes compared to the NPR-A?
- How important are springs and associated aufeis and ice-dam flooding events in supporting fish and wildlife habitat and river recharge?

What studies/surveys need to be conducted to fill those information gaps?

Rivers and groundwater springs (figure 2):

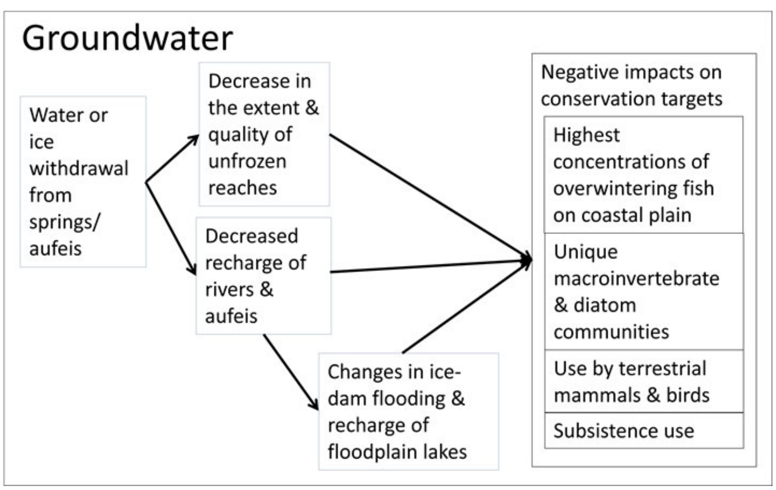

Figure 2. Adverse impacts of groundwater/ice withdrawals on fish, wildlife and subsistence.

Near-term and medium-term (starting FY18):

- Characterize seasonality in water quantity and quality to allow for science-informed NEPA processes and development of BMPs and permitting stipulations that ensure protection of fish and wildlife habitat and account for cumulative impacts of climate change. Conduct continuous water quality and quantity monitoring on the Hulahula, Tamayariak, and Canning rivers to evaluate the current status and natural variability in late fall and spring surface water quality

and quantity in relation to the timing of fish use and industrial activity (August 2018-2030: $175,000 per year, potential leads USGS, USFWS, BLM).

- Identify the extent and value of groundwater to delineate special areas and support science-informed NEPA processes, BMPs, and decisions regarding hazardous waste disposal that ensure protection of fish and wildlife and habitat:
    - Evaluate groundwater flow paths and recharge -- Develop a conceptual groundwater model informed by isotopic studies to delineate and age flow paths. Quantify river recharge rates to inform water withdrawal permits in areas that are primarily recharged from groundwater. (FY18-20 total cost: $$, potential leads: USGS and USFWS).
    - Identify open-water areas and aufeis-associated fish habitat and evaluate terrestrial mammal use of aufeis, aufeis contributions to late summer flows, and the importance of aufeis and ice-dam flooding in recharging fish and wildlife habitat in the Canning, Hulahula, Itkilyariak, Katakturak, and Sadlerochit river drainages (FY18/19 costs: $, USFWS and USGS).

Medium-term (starting FY19): seismic, development, production and restoration phases

- Evaluate efficacy of current practices and applicability to the coastal plain, 1002 area to support science-informed NEPA processes, BMPs, and restoration plans that ensure protection of fish and wildlife. Considerations must include effects on sheet flow, ice-dam flooding, and recharge of floodplains and differences between the coastal plain, 1002 area and the NPR-A.
    - Identify and conduct studies to minimize impacts of gravel extraction and infrastructure
    - Identify and conduct studies to ensure adequate restoration

Lakes (figure 3):

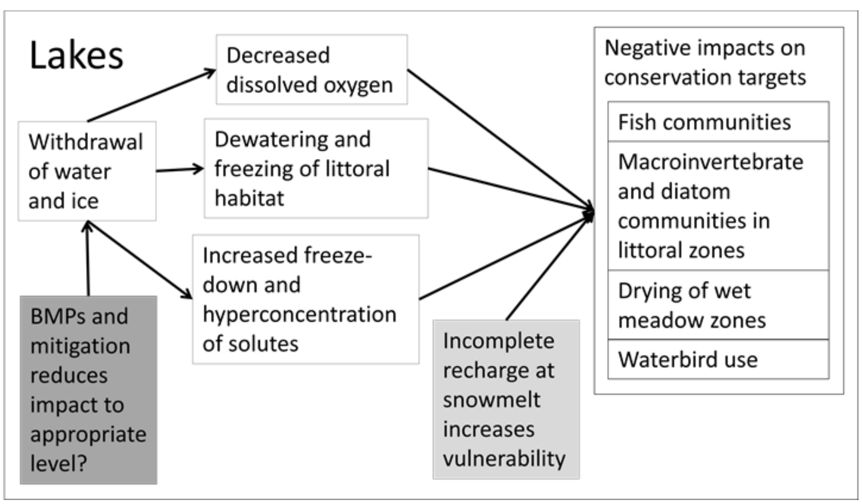

Figure 3. Adverse impacts of lake water and ice withdrawals on fish, wildlife and habitats.

Near to medium-term:

- Identify high-value and/or vulnerable lakes and characterize seasonality in water quantity and quality to allow for science-informed NEPA processes and development of BMPs and effectiveness monitoring protocols that ensure protection of fish and wildlife habitat with a known level of confidence (FY18-22 cost: $$, leads: USFWS, USGS, BLM).
    - Fish surveys have only been conducted in 2.3% of lakes in the 1002 area and most surveys were brief reconnaissance surveys only targeting nine spine stickleback. Fish distribution models and sample collection protocols have been developed for other

areas on the North Slope, but their applicability to the 1002 area is unknown. Macroinvertebrate diversity is an indicator of ecosystem health and has never been assessed in 1002 area. Baseline contaminants surveys of fish have only been conducted at a small handful of sites. To identify high-value aquatic habitats, inform planning, and provide baseline samples there is a need to document fish presence; test the applicability of existing fish survey protocols and distribution models, and collect baseline macroinvertebrate, fish e-DNA, and fish tissue samples to archive for future analysis (for more information, see resource assessment for contaminants). Results would include the following: traditional fish surveys in up to 60 lakes, validation of protocols and fish distribution models for applicability in the 1002 area, baseline macroinvertebrate and fish contaminant samples collected in up to 60 high-priority lakes, and e-DNA samples available to test for fish presence in up to 200 lakes. Refuge staff and two arctic fisheries biologists can conduct this field work in FY18. (FY 18 cost: $76,150, FY19 cost: $82,000, Lead: Greta Burkart, John Trawicki, Phaedra Budy, Angela Matz, Sandy Talbot, Damian Menning, and Robert Gerlach) Develop geospatial inventory of hydrologic connectivity, watershed areas and relative snowpack to assess lake vulnerability/recharge potential (FY18-20, leads: USGS, USFWS). Integrate this effort with surveys of snow pack (see resource assessment for snow and climate) and updates of the national wetland inventory updates (see resource assessment for wetlands) and national hydrography dataset.
    - Continuous water level and winter water quality monitoring on representative lakes to evaluate current status and natural variability relative to timing of potential impacts of industrial activities and use by fish and wildlife (FY18-22, leads: USFWS, USGS, BLM).
- Evaluate efficacy of current practices and applicability to coastal plain, 1002 area to support science-informed NEPA processes and BMPs that ensure protection of fish and wildlife.
    - Assessments of the adverse impacts of water withdrawal on lake biota in the NPR-A are necessary to assess the efficacy of existing BMPs (per National Research Council 2003). Comparing aquatic macroinvertebrate diversity in the NPR-A on 6 untapped lakes and 6 lakes where the entire permitted volume has been withdrawn and the vulnerability is similar to a range of lake types in the coastal plain 1002 area (FY18-19 costs: $80,000, potential leads: BLM, USFWS, USGS) will help assess the efficacy of existing BMPs. This effort would require 5 field days and could be conducted by the Arctic Refuge aquatic ecologist with assistance from BLM in identifying potential study lakes that are vulnerable to water withdrawals and have had permitted volumes withdrawn. Estimated costs for FY18 or 19: $63,480 (sample analysis by contract lab: 41,000, five days of field food: $230, helicopter and fuel: $21,850). Note the cost would be $10,000 cheaper and the project would have a lower carbon footprint if a helicopter already based on the North Slope is used. The power to detect change in macroinvertebrate community composition is unknown, but could at least be estimated if this study were conducted. If additional funds were available surveys of the following could be conducted as well: wet meadow zones, recharge rates, and winter water quality.

Geospatial:

Near-term:

- Cross reference existing technical reports to map any known areas of special values including Wild and Scenic Rivers, springs, subsistence use areas, and recreational areas (e.g. Canning River takeout). Identify data gaps in our knowledge in addition to those mentioned previously.

Medium-term:

- Develop NHDPlus High Resolution hydrography framework, which extends the hydrologic network seamlessly across the terrain by including not only streams and lakes, but also associated catchment areas that drain to each lake or stream segment. This association allows information about the landscape to be related to the drainage network. Observational data on the drainage network, such as water quality samples, stream gauge measurements, or fish distribution, can be linked to the framework, integrating data and facilitating analyses required during all phases of exploration and development. This effort should be combined with wetland and vegetation surveys (see resource assessment for wetlands and vegetation).

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